SKIN STAPLERS VERSUS SKIN SUTURES IN ELECTIVE AND EMERGENCY ABDOMINAL SURGERIES – A COMPARATIVE CLINICAL STUDY

Dissertation submitted to

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

CHENNAI, TAMIL NADU

For the degree of

MASTER OF SURGERY IN

GENERAL SURGERY

DEPARTMENT OF GENERAL SURGERY

TIRUNELVELI MEDICAL COLLEGE

TIRUNELVELI-627011

April 2014

ABSTRACT

TITLE : Skin staplers versus skin sutures in elective and emergency abdominal surgeries – A comparative clinical study.

AUTHOR : M . Natarajan

KEYWORDS : Sutures , Staplers, abdominal surgeries

BACKGROUND : Patients whom underwent abdominal surgeries in both elective and emergency operation theatres in Tirunelveli Medical College hospital was included in this prospective study. Patients were assigned to skin sutures/staplers for wound closure and 50 cases were studied in each group (total – 100 cases). Cases were studied from March 2012 – November 2013. The wound was closed by skin staples or sutures. The wound was evaluated after 1 week, 1 month and 3 month interval for infection, swelling, discharge, overlapping of edges, separation of edges, wound dehiscence and scar.

RESULTS : In our study, 5 patients[10%] in the stapled group and 17 patients[34%] in the sutured group had wound infection/discharge.Mean Wound cosmesis score was 3.5 in stapled group and 2.7 in sutured group. The P value was 0.001 and was statistically significant. The average score for post operative pain was 5.2 in stapled group and 6.8 in the sutured group. The average time required to approximate 1cm of wound was 9.96 seconds with staplers whereas it was 51.66 seconds with sutures.

CONCLUSION : Hence we conclude that skin staplers are superior to sutures for better wound cosmesis, in reducing the post operative pain, wound infection, seroma formation and very much significant in saving time for skin closure. Hence this study recommends the use of skin staplers.

CERTIFICATE

This is to certify that this dissertation titled **"SKIN STAPLERS VERSUS SKIN SUTURES IN ELECTIVE AND EMERGENCY ABDOMINAL SURGERIES – A COMPARATIVE CLINICAL STUDY"** is a bonafide work of Dr. **M. NATARAJAN**, and has been prepared under my guidance, in partial fulfillment of regulations of The Tamilnadu Dr. M.G.R. Medical University, for the award of M.S. Degree in General Surgery during the year 2014.

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This is to certify that the Institutional Ethical Committee of this College unanimously approves the Thesis /Dissertation/ Research Proposal submitted before this committee by Dr. NATARAJAN .M , a **POST GRADUATE STUDENT IN THE DEPARTMENT OF GENERAL SURGERY** in the Department of **GENERAL SURGERY**, of Tirunelveli Medical College /Hospital, Tirunelveli titled **"SKIN STAPLES VERSUS SKIN SUTURES IN ABDOMINAL SURGERIES – A COMPARATIVE CLINICAL STUDY "** registered by the IEC as 152/G.S/IEC/2011 dated. 22.03.2012. The Investigator is hereby advised to adhere to all the stipulated norms and conditions of this ethical committee.

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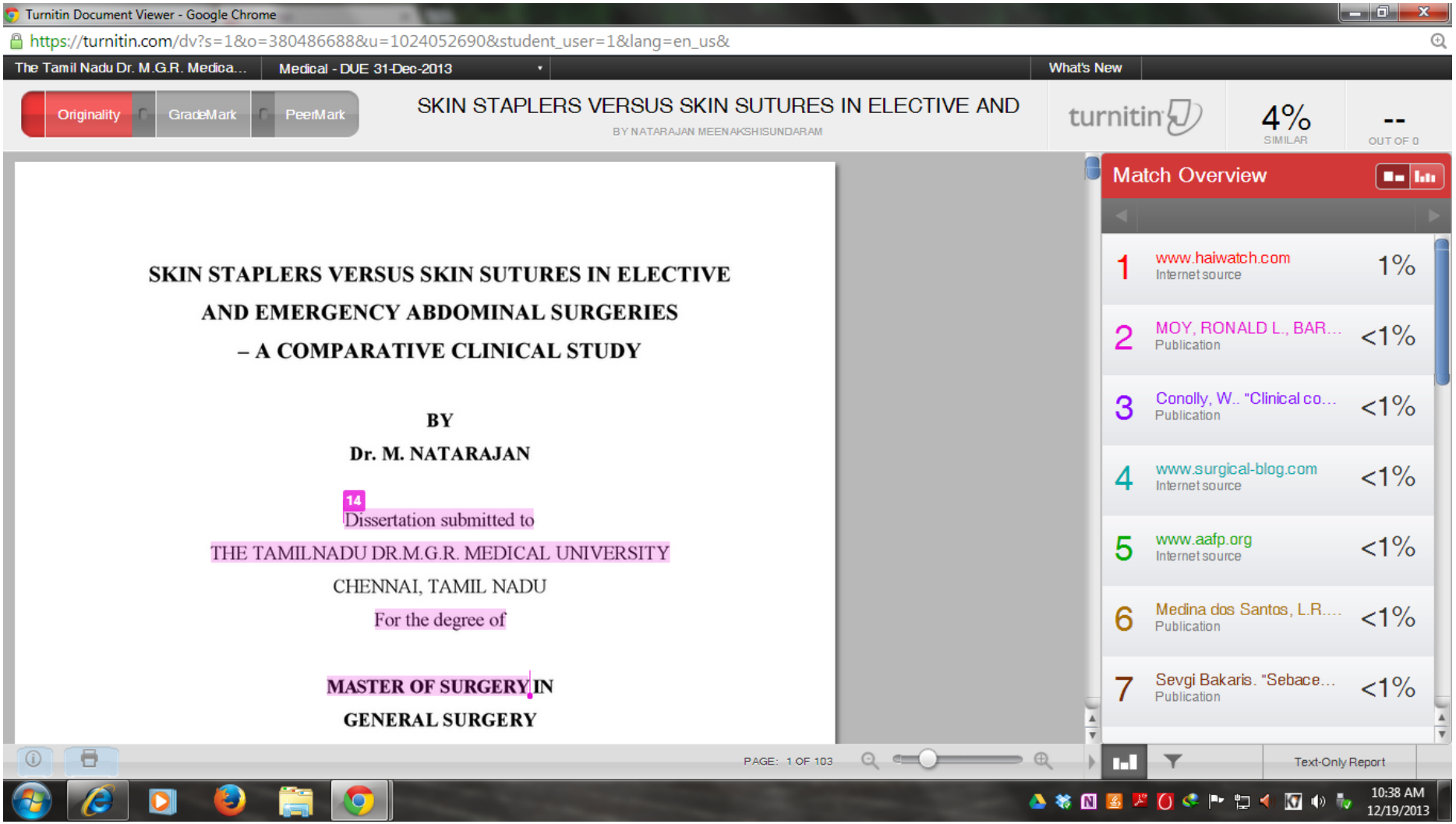
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I hereby declare that this dissertation / thesis entitled **" SKIN STAPLERS VERSUS SKIN SUTURES IN ELECTIVE AND EMERGENCY ABDOMINAL SURGERIES – A COMPARATIVE CLINICAL STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. R. MAHESHWARI M.S ,** Department of surgery, Tirunelveli Medical College, Tirunelveli– 627011.

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INTRODUCTION

The term surgery was coined from the earlier name chirurgery which means handwork. It is the science that reveals the manner of exercising all manual operations necessary to heal or as much as possible by using of most expedient medicines. Development of surgical skills and handling of instrument has led to the understanding of an operative intervention. Emergency operations and insertion of foreign bodies are undertaken when one is confronted with acute sepsis – adhesives and staples are substituted for sutures, balloons challenge the byepass and lasers the scalpel. The evence of modern surgeon is the ability to know what to use, when to use and for how long.

"Many surgeons have genius without industry, other have industry without genius while many have both are still in judgement" – John Abernethy.

To access the underlying pathology, any surgical procedures will result in a wound. The principlel idea is to get back the wound strength as quickly as possible with minimal damage to the tissues and an acceptable cosmetic scar. The important step is the accurate coaptation of dermal edges.

Surgical site infections is the most common nosocomial infections reported in hospital patients[5]. Upto 2.5% of patients undergoing clean extra

abdominal operations and upto 20% of intraabdominal operations will develop surgical site infections[6]. Infection is the most significant factor affecting wound healing[7]. The technique of closure of skin that penetrates the epidermis and dermis only serves to auto-inoculate the wound of the patient, driving surface flora deep into subcutaneous tissue[4].

Percutaneous suture closure also provides an additional source of contamination via the suture pathway. This results in a thin perisutural cuff of dead epidermis, dermis and subcutaneous fat. Suture closure is a significant source of foreign body reaction within the susceptible subcutaneous tissue[8].

AIMS AND OBJECTIVES

To compare skin staples with sutures for skin closure in abdominal surgeries for the following characters :

1. To compare wound infection/ discharge
2. To compare wound dehiscence
3. To compare wound cosmesis
4. To compare post operative pain
5. To compare time consumption

The advantages of staples include ease of use, dependability, reduce skin allergies, rapid speed of closure, a decreased risk of infection as there is less chance of bacterial migration into the wound and also the capillaries in the sub-cuticular layers are not damaged during placement of staples, improved wound edge eversion without strangulation of tissue and result in minimal cross hatch scarring, and less foreign body reaction.

Staple closure also eliminates the risk that a health care provider will experience a needle stick injury, which is particularly important in caring for patients with unknown medical histories.

Several studies in favour of sutures have shown that they are used to obtain a meticulous wound closure with greatest tensile strength and lowest likelihood of dehiscence.

Wound closure by sutures has shown to be better than staples in context of being less painful, yielding a much improved cosmetic result, being significantly cheaper, having lower rate of superficial wound complications and not requiring a special device for its removal as one is needed for staple removal.

Hence, in view of comparative studies done between sutures and staples having different outcomes, this study is being conducted to further evaluate the advantages and disadvantages of staples and sutures.

REVIEW OF LITERATURE

ANATOMY OF THE SKIN

The skin or the integument is the external organ that protects against mechanical trauma, UV light and infection. In addition,the skin is concerned with thermoregulation, conservation and excretion of fluids, sensory perception and of course has aesthetic role for appearance of the individual. The histology of the skin comprises 2 layers, the epidermis and the dermis.

EPIDERMIS

The epidermis is composed of following 5 layers

1)**BASAL CELL LAYER(STRATUM GERMINATUM):**The basal cell layer consists of a single layer of keratinocytes that forms the junction between the epidermis and dermis. The nuclei of these cells are perpendicular to the epidermal basement membrane. These are hyperchromatic and normally contain a few mitoses indicating that the superficial epidermal layers originate from the basal cell layer. These cells are interconnected with each other and with overlying squamous cells by desmosomes. Interspersed in the keratinocytes are melanocytes, a type of dendritic cells seen as every tenth cell in the basal layer. These cells have small nuclei with clear cytoplasm containing melanin pigment granules that determines the appearance of an individual. The other type of dendritic cells

in the basal layer are Langerhans cells which are bone marrow derived cells of mononuclear-phagocyte system.

2)**PRICKLE CELL LAYER(STRATUM SPINOSUM):** This layer is composed of several layers of polygonal cells or squamous cells. The layers become flat as they near the surface so that their long axis appears parallel to the skin surface. These cells possess intercellular bridges or tonofilaments. These intercellular cytoplasmic PAS positive material that is precursor of keratin.

3)**GRANULAR CELL LAYER(STRATUM GRANULOSUM):**This layer consists of 1 to 3 layers of flat cells containing keratohyaline basophilic granules which are PAS negative. Granular cell layer is much thicker in palms and soles.

4)**STRATUM LUCIDUM:** This layer is present exclusively in palms and soles as a thin homogenous eosinophilic non nucleate zone.

5)**HORNY LAYER(STRATUM CORNEUM)**: The stratum corneum is also normally devoid of nuclei and consists of eosinophilic layers of keratin.

Intraepidermal nerve endings are present in the form of Merkel cells which are touch receptors.

DERMIS

It comprises 2 parts superficial papillary dermis and deeper reticular dermis. It also consists of fibrocollagen tissue with blood vessels, lymphatics and nerves. The pacinian corpuscles are specialized nerve endings present at the deep layers of skin, which was concerned with pressure. The other specialized nerve endings are – meissners corpuscles (touch receptors), Ruffini's corpuscels (cold receptors) and end bulbs of Krause. It also contains adnexal structures as follows :

1)**SWEAT GLANDS:** These are of 2 types

***ECCRINE GLANDS:** They are present all over the skin but are most numerous on palms and soles and axilla.They are coiled tubular glands lying deep in the dermis. Their ducts pass through the epidermis on the surface of the skin as pores via which they empty their secretions. The glands are lined by two main types of secretory cells – basal acidophilic chief cells and the superficial basophilic dark granular cells.The secretory cells are surrounded by myoepithelial cells.

***APOCRINE GLANDS:** Apocrine glands are encountered in some areas only-in the axilla, in the anorectal region, in the external ear modified glands called ceruminous glands, in the eye lids as Moll's glands and in the breast as mammary glands. Apocrine glands are also tubular glands but have secretory cells which contain acidophilic PAS positive prominent granular

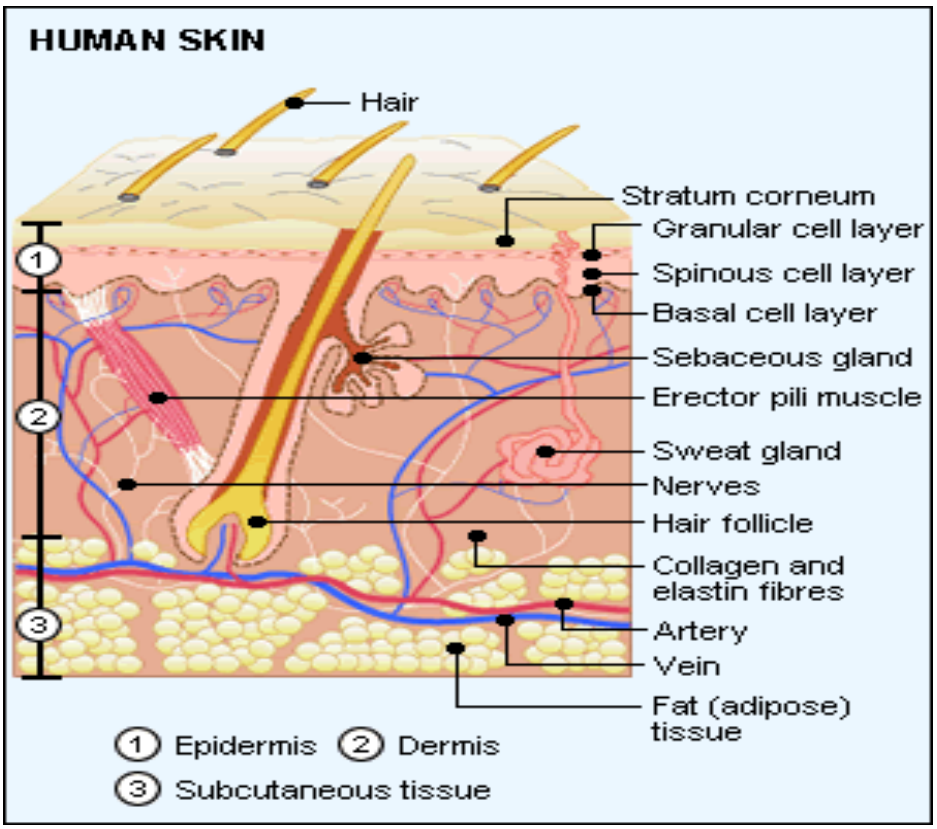
cytoplasm. The type of secretion in apocrine glands is decapitation secretion as if the cytoplasm of the secretory cells is pinched off.

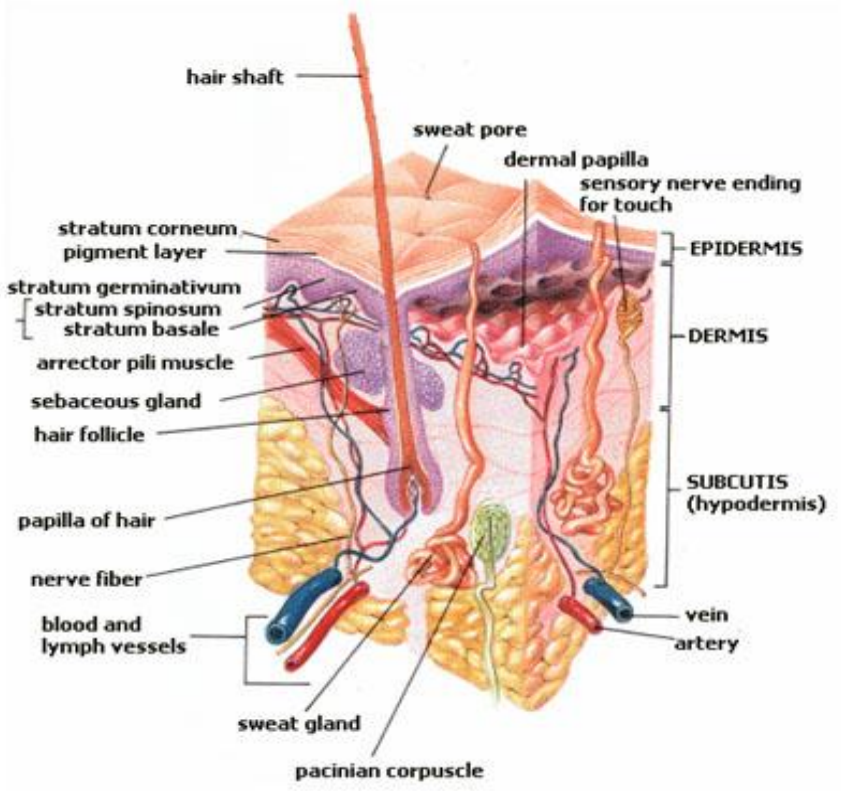
2)**SEBACEOUS(HOLOCRINE) GLANDS:** Sebaceous glands are found everywhere on the skin except on the palms and soles. They are very often found in association with hair such as in the external auditory meatus, nipple and areola of male and female breast, labia minora, prepuce and meibomian glands of the eyelids. Sebaceous glands are composed of lobules of sebaceous cells containing small round nuclei and abundant fatty network like cytoplasm.

3)**HAIR:**The hair grows from the bottom of the follicle. It has, therefore, an intracutaneou sportion present in the hair follicle and the shaft. The hair follicle consists of epithelial and connective tissue components. The hair shaft is made up of an outer sheath and pigmented cortex and inner medulla.

4)**ARRECTORES PILORI:** These are small bundles of smooth muscles attached to each hair follicle. When the muscle contracts the hair becomes more erect, the follicle is dragged upwards so as to become prominent on the surface of the skin producing what is known as the “goose skin”.

5)**NAILS:** The nails are thickenings of deeper part of the stratum corneum that develop at specially modified portion of the skin called the nail bed. The nail is composed of clear horny cells, resembling stratum lucidum but are much more keratinized.


HUMAN SKIN
Hair
Stratum corneum
Granular cell layer
Spinous cell layer
Basal cell layer
Sebaceous gland
Erector pili muscle
Sweat gland
Nerves
Hair follicle
Collagen and elastin fibres
Artery
Vein
Fat (adipose) tissue
1
2
3
1 Epidermis 2 Dermis
3 Subcutaneous tissue


hair shaft
sweat pore
dermal papilla
sensory nerve ending for touch
stratum corneum
pigment layer
stratum germinativum
stratum spinosum
stratum basale
arrector pili muscle
sebaceous gland
hair follicle
papilla of hair
nerve fiber
blood and lymph vessels
sweat gland
pacinian corpuscle
EPIDERMIS
DERMIS
SUBCUTIS (hypodermis)
vein
artery

HISTORY [1,2,3]

The act of sewing was as old as homosapiens. In susrutha samhita 600 B.C there was mention of suture material made from animal sinews, leather strips, vegetable fibers and braided home hair. The earliest wound closure was found in the Edwin smith papyreus written in Egypt around 3000 – 2500B.C. As early as 5000 – 3000 B.C eyed needles was used to suture the surgical wounds.

In 1600 B.C Egyptians used linen strip coated with honey and flour for skin closure. In 150 A.D, Galen of pergamon was the first to use plain catgut which was manufactured from intestines of herbivoures species and its applications are even used now.

Large black ants were used for wound closure by the South Americans. They bite the wound edges together using their powerful jaws similar to the Michael Clips. The ants body was then twisted off leaving the head in place.

In the presence of gross infection, when linen thread was used it was broken down rapidly. In order to overcome this situation, Avicenna, who was the prince of physicians, invented the first monofilament suture by using pig's bristles.

Albucasis, the prince of surgeons, was the first to describe a double suture which is still used today. Ambrose Pare, who was the father of surgery, used a method of dry suturing for facial wounds where strips of plaster were sticken down each side of the wound and then suturing the strips together.

John Hunter preferred using interrupted sutures and bandage or use sticking plaster across the wound. Physics also experimented with adhesive strips which was made of leather. He observed that these were dissolved after contact with wound discharge. His experiments were historic for considering the possibility of an absorbable suture.

In 1869, Joseph Lister noticed that where fragments of glass or needles inadvertently left in the wound did not predispose to abscess or infection. He concluded that harmful bacteria should lie with in the interstices of silk and if they are killed , a ligature could be left in situ. This led to the development of concept of Antiseptic ligatures. Lister incorporated chromic acid, which was used to tan leather, in to his formulation. In 1902, claudices introduced iodine sterilisation of sutures.

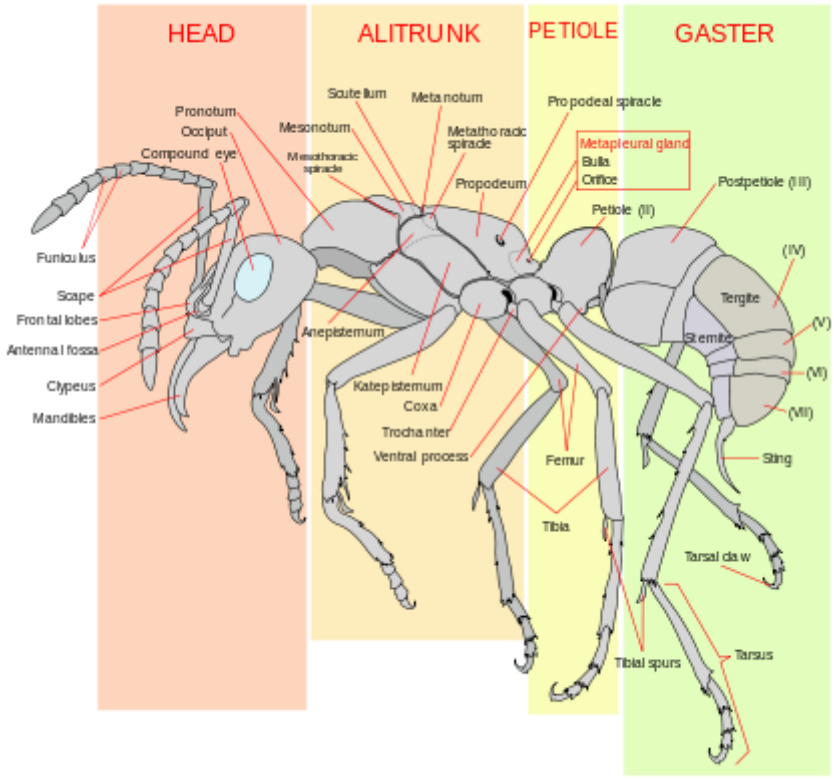
During the first world war, Britain was having little or no catgut industry. Local pharmacist George Merson undertook the commercial manufactures of this suture material. These were called as Mersutures. One of the most important technical advances in suture manufactures was

introducing sterilisation by irradiation using Cobalt 60 isotope in 1960. This was a revolutionary development in suture packaging as it overcame the difficulties in aseptic transfers.

Because of excellent handling properties, silk was the suture of choice in non-absorbable suture range, as the linen and cotton were already in use. Polyester and polyamide were introduced and almost replaced these non absorbable sutures. Polyester was manufactured as braided, coated and non-coated. Now polyester is available as monofilament. Then monofilament polypropylene was made, which was considered fulfilling many characteristics of ideal suture material. It almost replaced silk, cotton and linen.

Then was the era of synthetic absorbable sutures. In 1931, the development of synthetic absorbable sutures began with the production of synthetic absorbable fibre of polyvinyl alcohol. In 1960's polyglycolic acid was processed into an absorbable suture material with favourable suturing properties. Then glycolide and lactide was combined with it to develop polyglactin 910, vicryl and monocryl were developed from then on.

In 1908, HultiHumer in Australia developed the concept of surgical stapling. This instrument weighed 7.5 pounds. This was later modified by Von Petz and Frederick of Alm to make the modern linear stapler.


HEAD
ALITRUNK
PETIOLE
GASTER
Pronotum
Occiput
Compound eye
Scutellum
Mesonotum
Mesothoracic spiracle
Metanotum
Metathoracic spiracle
Propodeum
Propodeal spiracle
Metapleural gland
Bulla
Orifice
Postpetiole (III)
Petiole (II)
(IV)
Tergite
(V)
Sternite
(VI)
(VII)
Sting
Funiculus
Scape
Frontal lobes
Antennal fossa
Clypeus
Mandibles
Anepisternum
Katepisternum
Coxa
Trochanter
Ventral process
Femur
Tibia
Tarsal claw
Tibial spurs
Tarsus

WOUNDS AND WOUND HEALING

WOUNDS

DEFINITION:

A wound is a break in the integrity of the skin or tissues often, which may be associated with disruption of the structure and function.

CLASSIFICATION OF SURGICAL WOUNDS :

1. *Clean wound*

Elective, not emergency, non traumatic, primarily closed, no acute inflammation; no break in technique; respiratory, gastro-intestinal, biliary and genito-urinary tracts not entered.

- Herniorrhaphy.
- Excisions.
- Surgeries of the brain, joints, heart transplant.
- Infective rate is less than 2%.

2. *Clean contaminated*

Urgent or emergency care that is otherwise clean; elective opening of respiratory, gastrointestinal, biliary or genito urinary tract

with minimal spillage (e.g. appendicectomy) not encountering infected urine or bile; minor technique break.

- Appendicectomy.
- Bowel surgeries.
- Gallbladder, biliary and pancreatic surgeries.
- Infective rate is 10%.

3. *Contaminated wound*

Non purulent inflammation ; gross spillage from gastro intestinal tract; entry into biliary or genitourinary tract in the presence of infected bile or urine; major break in technique, penetrating trauma <4hours old; chronic open wounds to be grafted or covered.

- Acute abdominal conditions.
- Open fresh accidental wounds.
- Infective rate is 15-30%.

4. *Dirty infected wound*

Purulent inflammation, pre-operative perforation of respiratory, gastro intestinal, biliary or genitourinary tract, penetrating trauma >4hrs old.

- Abscess drainage.

- Pyocele.
- Empyema gallbladder.
- Faecal peritonitis.
- Infective rate is 40-70%

Wound Healing

"A scab is a beautiful thing – a coin the body has minted with an invisible motto: In God We Trust. Our body loves us and, even while the spirit drifts dreaming, works at mending the damage that we do".

- **JHON UPDIKE , 1984**

TYPES OF WOUND HEALING

- ***Primary Healing (First intention):***

  It occurs in a clean incised wound or surgical wound. Wound edges are approximated with sutures. There is more epithelial regeneration than fibrosis. Wound heals rapidly with complete closure. Scar will be linear , smooth and supple.

- ***Secondary Healing (second intention):***

  It occurs in a wound with extensive soft tissue loss like in major trauma , burns and wound with sepsis. It heals slowly with fibrosis. It leads into a wide scar , often hypertrophied and contracted. It may lead into disability.

STAGES OF WOUND HEALING

- Stage of inflammation.
- Stage of granulation tissue formation and organization.
- Stage of epithelialisation.
- Stage of scar formation and resorption.
- Stage of maturation.

PHASES OF WOUND HEALING

INFLAMMATORY PHASE: (Lag/substrate/exudative phase)

It begins immediately after wound healing. It lasts for 4-6 days. Features of inflammation are rubor, calor, tumour, dolor and loss of function. Macrophages secrete fibroblastic growth factor which enhances angiogenesis. Polymorphonuclear leukocytes (PMN leukocytes) appear after 48 hours which secrete inflammatory mediators and bactericidal oxygen derived free radicals. These cells also removes clot, foreign bodies and bacteria. Chemical factors involved in wound healing are growth factors-platelet derived, epidermal, transforming ; interleukin ; tumour necrosis factor ; prostaglandins ; collagenase ; elastase.

PROLIFERATIVE PHASE: (Collagen/Fibroblastic phase)

Collagen and glycosamines are produced by fibroblasts. It begins in 7 days and lasts for 6 weeks. Hydroxylproline and hydroxylysine are

synthesized by specific enzymes using iron, alpha ketoglutarate and vitamin C. Tropocollagen is produced which aggregates to form collagen fibrils 80-90% of their final strength (in postoperative wounds) is achieved in 30 days.

REMODELING PHASE: (Maturation phase)

It begins at 6 weeks and lasts for 2 years. There is maturation of collagen by cross–linking which is responsible for the scar. Collagen production is not present after 42 days of wound healing.

FACTORS AFFECTING WOUND HEALING

LOCAL FACTORS:

- Infection.
- Presence of necrotic tissue and foreign body.
- Poor blood supply.
- Venous or lymph stasis.
- Tissue tension.
- Haematoma.
- Large defect or poor apposition.
- Recurrent trauma.
- X-ray irradiated area.
- Site of wound, e.g. wound over the joints and back has poor healing.
- Underlying diseases like osteomyelitis and malignancy.

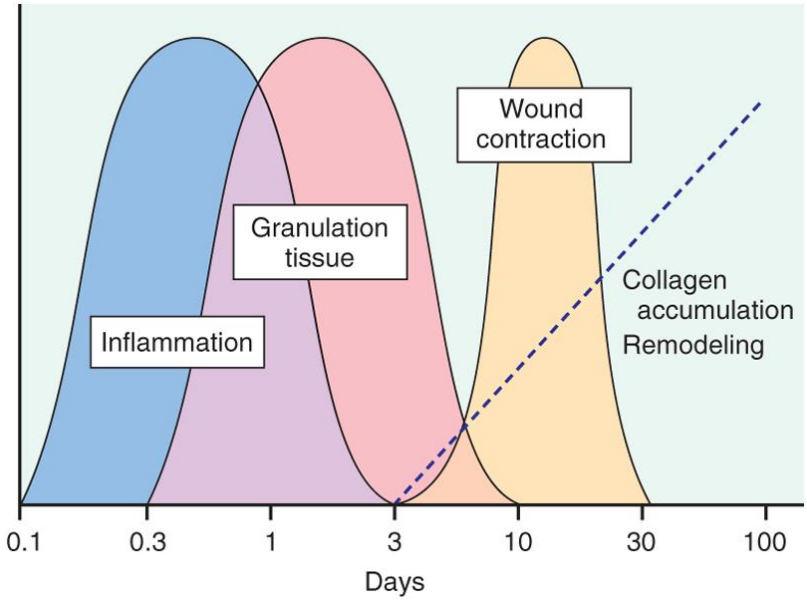
- Mechanism and type of wound – incisied/lacerated/crushed/avulsion.

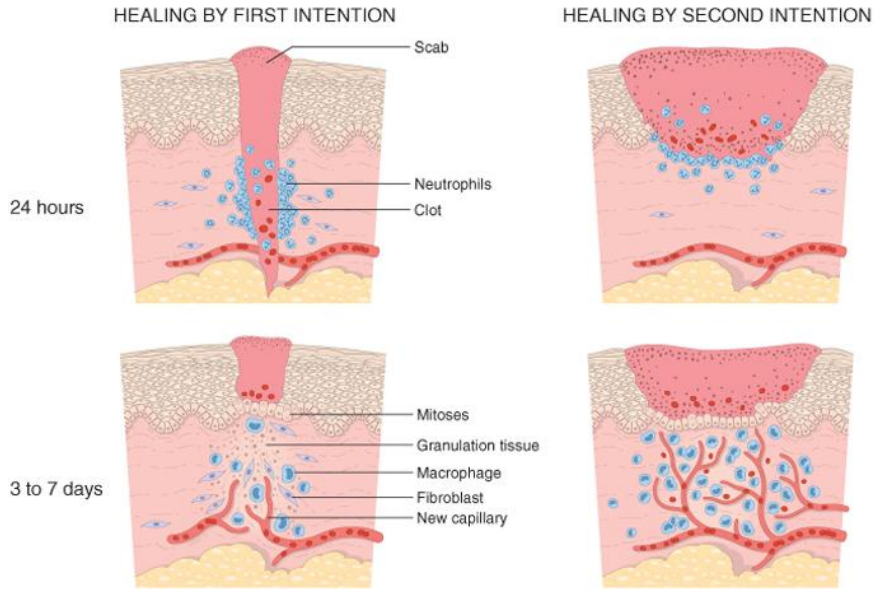
GENERAL FACTORS:

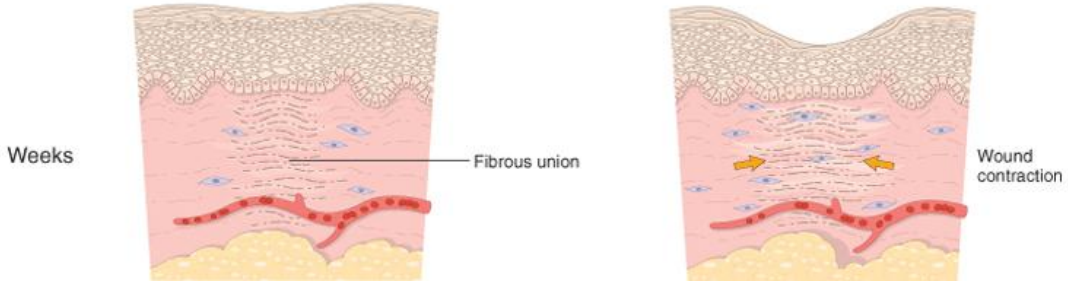
- Age, obesity, smoking.
- Malnutrition.
- Anaemia.
- Malignancy.
- Uraemia.
- Jaundice.
- Diabetes, metabolic diseases.
- HIV and immunosuppressive diseases.
- Steroids and cytotoxic drugs.
- Neuropathies of different causes.

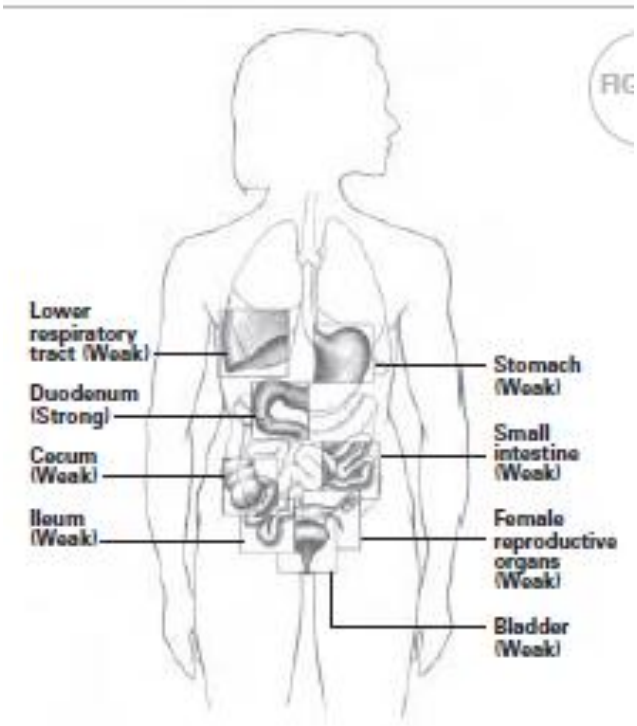
Complications of wound healing

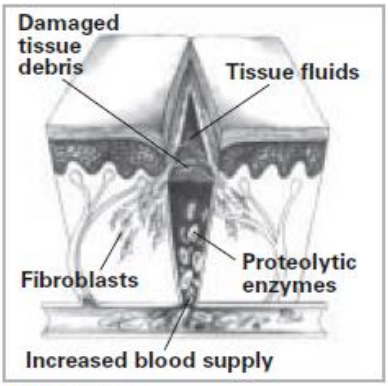
1) Implantation cyst
2) Painful scars
3) Keloid formation
4) Neoplasia
5) Cicatrisation
6) Wound gaping


Wound contraction
Granulation tissue
Collagen accumulation
Remodeling
Inflammation
0.1
0.3
1
3
10
30
100
Days

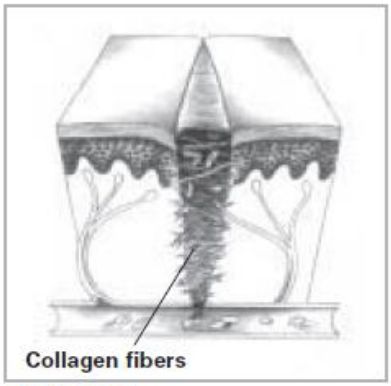

HEALING BY FIRST INTENTION
HEALING BY SECOND INTENTION
Scab
24 hours
Neutrophils
Clot
3 to 7 days
Mitoses
Granulation tissue
Macrophage
Fibroblast
New capillary


Weeks
Fibrous union
Wound contraction

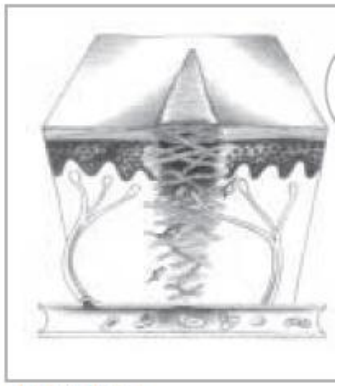




PHASE 1–
Inflammatory response and debridement process



PHASE 2–
Collagen formation (scar tissue)



PHASE 3–
Sufficient collagen laid down

SUTURE

Suture denotes sewing by means of needle and a thread, made up of a suture material. Suture materials are required to keep the wounds together until they hold sufficiently well by themselves by natural fibres (collagen) to from a strong scar. Suture materials are mainly divided into 2 groups – absorbable and non-absorbable. These are again may be of natural or synthetic variety.

Depending on the number of strands in the suture materials sutures may be

1) Monofilament sutures :

These are sutures made of a single strand of fibre. These sutures are smooth and strong. Chance of bacterial contamination is less. The disadvantage is that knot tied may become loose.

Examples – Polypropylene, polyamides, catgut, monocryl, polydiaxanone, polyglactin finer sizes 6/0 – 9/0

2) Polyfilament sutures :

These sutures consists of multiple strands braided together. They are easier to handle and knot tied does not slip. The disadvantage is that the bacteria may lodge in the cervices of the sutures so that these sutures are not suitable in the presence of infections

Example - silk, linen, polyglycolic acid, polyglactin 9/0, braided polyamide ,braided polyester.

Criteria of an ideal suture material :

1) should have adequate tensile strength
2) should incite minimal tissue reaction
3) should have easy handling property
4) should have good knotting property
5) should be non-allergic& non-carcinogenic
6) should be easily available & cheap
7) should be able to stretch to adjust wound edema.
8) ability to recoil to its original strength during wound contraction

Properties of suture material:

1) Knot strength

It is defined as the measurement of amount of force needed and its relation to co-efficient of friction of a given material.

2) Tensile strength:

It is the measurement of quantity of weight necessary to break a suture to its cross sectional area.

3) Elasticity

It is defined as the intrinsic tension developed with in the suture after some lengthening that makes it to regain its original strength.

4) Memory

It is defined as the inherent ability of the suture material to regain its original shape after being handled. It is the property of stiffness of the material.

ABSORBABLE SUTURE

NATURAL

***Catgut* –** The surgical catgut today is prepared from the submucosa of the first one third of small intestine of government inspected sheep or cow. Excised intestine is mechanically cleaned and they are subjected to a stripping process which removes the muscle from one side and mucous membrane from the other. Casings of 16 – 18 metre diameter are preserved in ice or salt and transported to the suture factory where they are split longitudinally into two or three ribbons. Further mechanical cleaning ensures that the final ribbon is pure submucosal collagen. The ribbons are then chromed , twisted together and slowly dried under tension. Chromic catgut is made by treating catgut with chromic acid salt to effect cross linking, which delays hydrolysis. Absorption is unpredictable particularly in

contaminated or infected wounds, so predictable synthetic absorbables is more preferred nowadays.

This is now polished and sorted for size. It is sterilised by gamma irradiation or ethylene oxide and packed in fluid containing 70% alcohol with glycerol and water to maintain flexibility. Plain catgut is absorbed in a week, whereas chromic catgut lasts for 10 to 40 days. The catgut is supplied in sealed glass tubes already sterilised and ready for use. All that is necessary is the sterilisation of the outside of the glass container. It cannot be boiled, as it denatures the catgut. It is immersed in 20% Lysol solution or 1 in 20 carbolic lotion for 24 hours for sterilisation.

It can be quickly sterilised by keeping it under pure Lysol for 30 minutes. The catgut has been graded according to thickness and strength from 0000(4/0) to 4. The fine catgut is used for tying subcutaneous blood vessels and fat ; No. 0 is used for peritoneum. Ofcourse, in emergency when one finds difficulty in closing the peritoneum, it is better to use No.1 catgut. No. 1 is also used for suturing muscles, fasciae and named blood vessels. Chroming not only delays absorption but significantly reduces the tissue irritation.

Advantage :

1. It can be used even in the presence of infection.

2. With chromic catgut, the presence of infection does not cause catastrophic fall in strength.

Disadvantages :

1.Tensile strength is lost much faster than the material is absorbed.

2. Irritant

3. Knot holding is still not ideal

4. The source is undeniably septic and purity of the product is subject of doubt. If not properly sterilised it itself can initiate virulent infection like tetanus.

5. Not very cheap

6. Triggers immune response

SYNTHETIC

Polyglycolic acid – It is made up of polymerized hydroxyaceticacid

(polyglycolic acid). It is absorbed in a slower and more predictable fashion than catgut. This material is liquefied, extruded as filaments, stretched and braided to form a suture. Size 0 contains 192 filaments, while 3/0 contains 80 filaments. It is sterilised with ethylene oxide.

Advantages :

1. Great tensile strength

2. Very little tissue reactivity.

3. It disappears at 60 – 90 days, much later than catgut by a process of slow hydrolysis.

4. It knots well.

Disadvantage

1. Tensile strength falls in 15 days.

Polyglactin (vicryl) – It is braided. It retains its strength and integrity for a long time in tissues. It is ideal for bowel anastomosis. It handles well and the knots are secured as it is braided. It is available in various sizes from 9/0 to 1. These sutures are also digested by hydrolysis and there is almost known tissue reaction. These sutures are available as monofilament as well as polyfilament type. It maintains tensile strength in the tissues for about 30 days and gets absorbed in 80 to 90 days. It is used mainly in the abdomen for various anastomosis and also for vascular surgery.

Vicrylrapide – It is undyed and it is absorbed rapidly which has been achieved by exposing quoted vicryl suture to Gamma radiation. It maintains tensile strength for 10 to 12 days and gets absorbed in 40 days. It is mainly used for subcuticular suture. It may even be used for skin suture where the suture need not be removed. It is specially used for circumscision.

Monocryl suture – It is a monofilament suture. It is composed of 75% glycolide and 25% caprolactone – forming polyglecaprone. It is also available in either undyed form or dyed form in violet color. It has a good handling property and passes through the tissues easily and it has double the strength of chromic catgut. The tensile strength exists for 21 days and it is absorbed by hydrolysis in about 100 to 120 days. It is sterilised by ethylene oxide. It is mainly used as a substitute for catgut. It may be used in pyeloplasty or ureter repair,intestinal anastomosis and for closure of peritoneum.

Polydioxanone (PDS) – It is also a monofilament suture. It is dyed violet. It is soft and smooth and very easy in handling and knotting characteristic is also the best among the synthetic absorbable suture. It maintains its tensile strength for about 60 days which is probably the highest. It is absorbed by hydrolysis in about 180 to 200 days. It is mainly used in abdominal operations especially gastro-esophageal anastomosis or intestinal anastomosis or biliary enteric anastomosis.

NON-ABSORBABLE SUTURE

NATURAL

Silk – It is a natural suture as presented as a silicone coated nonabsorbable braid. It has great strength and can be handled well with secure knots. It is the continuos protein thread spun by silkworm larva in making its cocoon. The fibre consists of a central core of fibrin covered with a thin layer of serecin (the silk albumin) which is usually removed. Most surgical silk is braided to give it added strength and better holding qualities. Floss silk is a loosely twisted silk fibre believed to encourage the infiltration of fibroblasts and incorporation with collagen to provide a strong repair of hernias. Repeated boiling or autoclaving does not reduce the tensile strength although the knot becomes more friable.

Black braided silk mounted on atraumatic needles are available as Mer silk. Mer silk can be of different sizes from 7/0 to 1. Silk sutures are sterilised by gamma irradiation. It is used where we want the suture material to exist not be absorbed. In abdominal operation particularly in case of ligating the pedicles during nephrectomy or splenectomy, this suture is used. In case of Truncal vagotomy, this suture is used to ligate the anterior and posterior vagus nerves before their division. It is also used to ligate cystic artery and cystic duct during cholecystectomy.

Mer silk is often used to repair the posterior wall of inguinal canal in herniorrhaphy. It may also be used in case of nerve suture when 4/0 Mer silk is used.

Advantages :

1. Size of silk is stronger than catgut.

2. It is the best handling materials.

3. It knots well.

4. It does not slip even if the ends are cut short.

Disadvantages :

1. Silk is capillary. It allows the passage of tissue fluid along the strand, so acts as a Wick to conduct infection from one place to another. It can be made non-capillary by either wax or silicone.

2. It is more irritating to the tissue than the synthetic sutures. It incites a polymorphonuclear reactions. It is especially troublesome if infection presents. The wound refuses to heal until the offending stitch is removed.

3. It loses all its effective strength after 6 months in the tissues.

4. Its capillary encourages infection and for that it is losing popularity as a skin Suture. Suture abscess more often occur following silk suture.

Silkworm gut – This is sometimes called “unspun silk”. The silkworm is killed before it is ready to spin its cocoon. The raw silk precursor is removed from the silk sac and is hardened to form strands of 12inches length. It cannot be more than 16 inches. It is a monofilament.

Advantages :

1. It is smooth.
2. It is strong and inert.
3. It can be autoclaved without damage.

Disadvantage :

1. It lacks flexibility and ties with difficulty.
2. It doen not have any advantage over the synthetic monofilament.

Cotton – It is a vegetable material composed of the unicellular hairs from the seeds of the plant. Its main advantage is that it is less irritant. Yet it needs meticulous aseptic technique during use. Its disadvantage is that it is the weakest suture material. It gains strength when wet. When combined with polyester it is a stronger material.

Linen – It is a cellulose material, made from the twisted long staple flax fibres. It handles well and is cheap. Its use is largely restricted to gastro intestinal surgery and practically has no advantage over silk.

SYNTHETIC

Polyamides(Nylon) – There was a wide range of synthetic non absorbable sutures now available which offer great strength and are relatively inert in tissues. Monofilament nylon is difficult to tie, but is ideal for closure of the abdominal muscular aponeurosis. Braided nylon is much easier to handle and is suitable for hernia repair. Nylon is a synthetic polyamide and is widely used in skin suture.

Monofilament polyamide is mainly used for closure of skin incision and also for closure of abdominal wall incision.

Advantages :

1. It is inert and can be used in presence of infection.

2. It is stronger than silk.

3. It can be autoclaved thrice before it loses its strength.

Disadvantage :

1.It does not knot nicely.

2. It requires multiple knots for security.

3. It is difficult to handle.

4. It loses its strength as time passes off.

Polyester – It is a braided suture. It is better known by its trade name of DACRON and TERYLENE.

Advantages :

1. It handles well.
2. It maintains high tensile strength in tissue indefinitely.
3. It is serum proof.
4. It can be autoclaved several times without damage.

Disadvantage :

1. The knot is not very secure.

Polyethylene – This high molecular weight polymer provides a strong inert suture material. It has high tensile strength and is plicable. It cannot be autoclaved, so sterilised by ethylene oxide. Its quality of being absolutely inert, has given birth to mesh, which is widely used in hernia surgery. It gradually loses its strength and ultimately breaks so it is unsuitable for cardiovascular surgery.

Polypropylene – It is a polymerised propylene, extended into monofilament and coloured bright blue for its recognition in the tissue. It is very much inert, so often used in mesh for hernia repair. Tensile strength is high and well maintained upto 24 months. It can be autoclaved atleast three times

without any loss of strength. Its only disadvantage is difficulty in knotting, but atleast better than nylon. This is ideal for vascular anastomosis.

This suture is available in various sizes from 8/0 to 1. This is ideal for vascular anastomosis. This is used almost always in case of mesh repair of the posterior wall of the inguinal canal in case of herniorrhaphy. Infact this polypropylene material is used in polypropylene mesh, which is mainly used in mesh repair. It is also used for repair of incisional hernias, 2/0 or 3/0 sutures are used for tendon injuries. Finer sutures e.g. 4/0 or 5/0 are used for repair of nerve injury and even for vascular anastomosis.

Stainless steel – The soft iron alloy containing chromium, nickel and molybdenum is the best. Its use has been very much restricted nowadays, but even then it is used in fracture patella to suture the fragmented patella. It is also used in case of fracture olecranon to suture the fragments together. It is used in Thiersch's operation for prolapse of rectum and also for interdental wiring in case of fracture mandible.

Advantages :

1. It has high tensile strength.

2. It is flexible and may be tied into a knot which has the security of all the suture materials.

3. It is extremely inert and can be safely used even in presence of Infection.

4. It can be autoclaved indefinitely without any harm to the suture material.

Disadvantage :

1. It may break if the material is kinked .

SKIN STAPLERS

The skin staplers have almost replaced or has evolved as an alternative to sutures to close skin wounds – Dermal adhesives have also emerged as common alternative.

History

In 1908 HumerHultl, a Hungarian surgeon who was known as “the father of surgical stapling”, was the first person to discover this technique. The stapler which he used weighed 8 pounds (3.6kg) requiring few hours to make it functional.

The instruments used by Hultl, Petz, Nakayama and Fredrich was complicated and was difficult to use. So this technology was refined by United States Surgical corporation (which later became Covidien in 2007) and Johnson & Johnson’s Ethicon, making the usage of stapler much easier and simple.

Types and applications

The skin staplers were made of either stainless steel with titanium stapler or plastic. Both are applied over the skin using disposable cartridges. The Titanium staplers also contain some amount of Nickel in it, which was responsible for some allergic reactions. One of the greatest advantage with Titanium stapler is that of being non-ferrous, hence they never interfere with MRI scan even though some artefacts are produced.

One of the recent advances in the development of skin staplers is the development of bio-absorbable staplers (which were made of polyglycolic acid)

INDICATIONS AND USAGE

Skin stapler were used widely for closure of scalp, abdomen, extremity and thorax incisions. Once the stapler was released from its cartridge, it forms an incomplete rectangle where its legs extend through the skin and the cross limb over the skin surface thereby bringing the edges of the wound together. The angle at which skin stapler entered the tissues and the precocking mechanism are the 2 most important characteristics while using skin staplers.

The deeper penetration in to the tissues occurs when stapler are placed perpendicular to the skin suface. This increases the chance of permanent cross hatching of the wound and strangulation of the tissue.

Hence staplers should be applied at either 45 degree or at 60 degree angle. This is because when the wound swells, the stapler placed at acute angle will rotate to vertical position to accommodate the swelling (when it occurs during the healing process). If the stapler was placed perpendicularly, the stapler cannot rotate & hence the tissue will strangulate[16]. The precocking mechanism helps the operating surgeon in keeping up a constant control while stapling. Using toothed forceps the wound edges are everted and lined up, so that the wound edges align with the marker on the head of the stapler (at the centre of the stapler head), only then the legs of the stapler will penetrate the skin at equal distances on either side of the edges of the skin. The first assistant aligns the wound by everting the edges of the wound using toothed forceps and advances as the operating surgeon staplers to approximate the wound. Then the staplers were disengaged by releasing the handle.

Configuration of a stapler :

	Regular stapler	Wide stapler
Diameter	0.53mm	0.58mm
Span	5.7mm	6.9mm
Length	3.9mm	3.9mm

ADVANTAGES

1. Swift application.
2. Attenuates the incidence of surgical site infections.
3. Decreases skin allergy.
4. User friendly (easy to use).
5. Reliability.

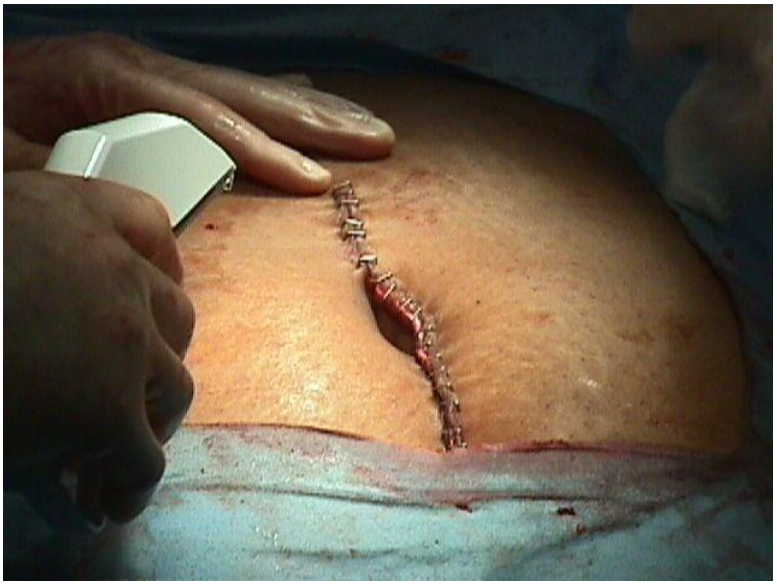
DURATION FOR STAPLER REMOVAL

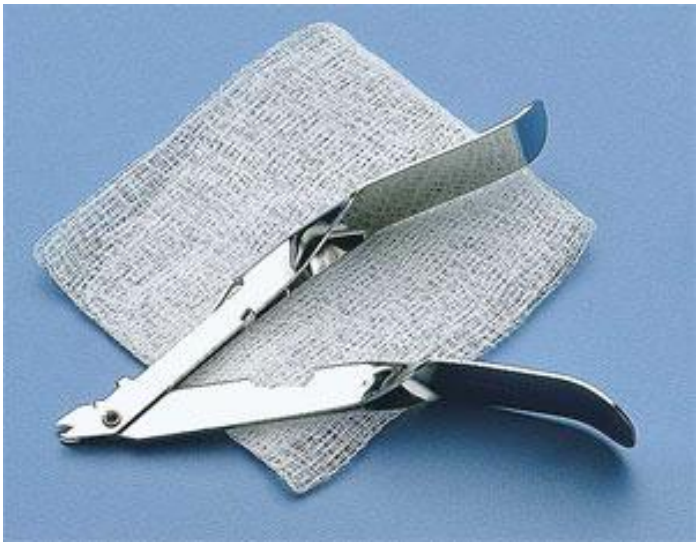
Skin stapler applied for procedures in the abdomen and chest areas are kept in situ for 10 – 14 days. This ensures good wound healing and also reduces the risk of delayed wound gaping.

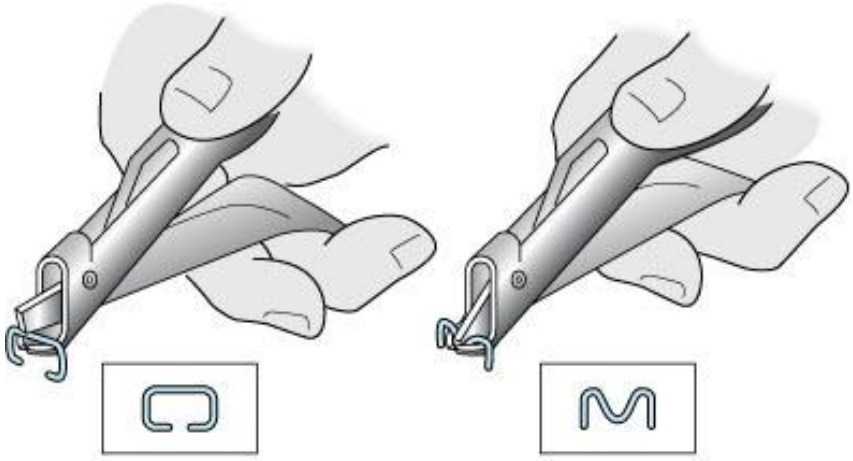
METHODS OF STAPLER REMOVAL

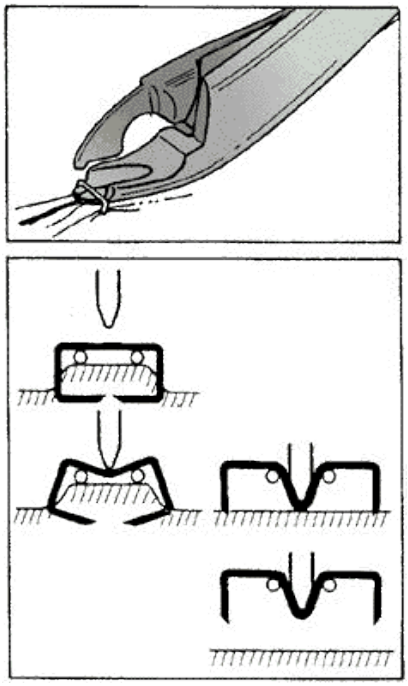
Stapler removal is usually painless. Cautious & carful removal of the skin stapler ensures minimal tissues damage and also reduces the risk of wound infections. Cleanse the hands with soap and dry it. Wear the gloves. Count the number of staplers holding the skin edges. Using a skin disinfectant like alcohol or betadine, clean the incision and allow it to dry. Now place the stapler remover under the first staple(which is usually at the end of the incision) in such a way that the lower jaw of the remover is under the stapler and upper jaw above it. Now release the stapler from the skin by squeezing the stapler remover. The legs of the stapler will bend slightly.

Dispose the stapler in a container. At the end, count the number of removed stapler and ensure that all the staplers are removed.









PROXIMATE* RH Skin Staplers (Rotating Head Skin Staplers)		PROXIMATE* PX Skin Staplers		PROXIMATE* PLUS MD Skin Staplers (Multi-Directional Skin Staplers)	
Features	Benefits	Features	Benefits	Features	Benefits
Rectangular staples	Minimizes staple rotation	Ergonomic pistol grip	Intuitive and comfortable to use	Improved kick-off spring design	Multi-direction release
Head rotates 360°; cartridge is clear	Improves visibility and access	Positive ratchet mechanism	Easy staple placement	Ergonomic design	Comfortable for smaller hands
Staples are coated with lubricant	Easy staple extraction	Staples are coated with lubricant	Easy staple extraction	Alignment indicator	Improves visibility
Pistol-grip handle	Comfortable to use			Staples are coated with lubricant	Easy staple extraction

ABDOMINAL INCISIONS

The Midline incision- It has got the advantage that it offers equal access to both sides of the abdomen. Moreover the number of layers divided in this is less, so the incision can be made quicker . Another advantage is that the incision passes through relatively avascular plane of abdomen so bleeding will be less

In this incision the skin, subcutaneous tissue and linea alba are divided to expose the transversalis fascia, which covers the peritoneum. Transversalis fascia and peritoneum are divided in one layer. So practically the incision goes through three layers- the skin, the lineaalba and the peritoneum covered by transversalis fascia.

In the upper abdomen the incision is quite suitable for operations of the stomach, duodenum, pancreas etc. In this region linea alba is quite tough and the strength of the suture is quite adequate to prevent incisional hernia. But in lower abdomen though used quite often by gynaecologists, the linea alba is relatively weak and form a weak scar, which may yield to produce incisional hernia. In the upper abdomen the incision is made slightly to one side to avoid entering between the layers of the falciform ligament.

Closure of the incision is performed by suturing three layers – the peritoneum with transversalis fascia, the linea alba and the skin.

Traditionally the peritoneum and transversalis fascia are sutured with round bodied needle and number 0 catgut. Cutting needle and number 1 catgut are used for suturing linea alba. For skin , straight cutting needle and black silk are used. Sometimes tension sutures may be required if there be difficulty in bringing together the layers. These tension sutures are applied before the linea Alba is sutured. Generally nylon or silk or prolene suture is used. Curved cutting needle is used to pierce the skin and lineaalba from one side to the other about 2 cm away from the margins of the incision. The two ends of the sutures are held together with artery forceps, to be tied after orthodox closure of the abdomen. These tension sutures are never tied lightly as this may strangulate the tissues held within and delay healing. So these sutures are tied through small rubber tubes or over rolls of gauze pieces. If possible, buttons may be used, so that the original abdominal suture remains uncovered for inspection. In cases of urgency rapid closure may be brought about by through and through stitches including all layers of abdomen.

Paramedian incision-The advantage of this incision is that it provides a strong scar.The intact rectus muscle intervenes between the sutured peritoneum and the anterior rectus sheath, so that the chance of incisional hernia is remote.

The incision is made parallel to the midline at a distance of about 1 inch lateral to it.The skin, subcutaneous tissue and anterior rectus sheath are

divided along the line of incision. The medial margin of the divided rectus sheath is held by a few artery forceps and lifted up.With sharp dissection the tendinous intersections are divided,so that the rectus muscle becomes free from its anterior sheath.The rectus muscle is now retracted laterally thus keeping intact its nerve supply to expose the posterior rectus sheath.The posterior rectus sheath, the transversalis fascia and the peritoneum are incised in one layer in the line of incision.

The incision is closed in three layers-peritoneum, transversalis fascia and the posterior rectus sheath in one layer. The rectus muscle is allowed to fall on this suture line. The anterior rectus sheath is sutured as the 2^{nd} layer and the skin being the last layer.

Rectus muscle splitting incision-This incision is made about 3-4cm lateral and parallel to the midline.The skin, subcutaneous tissue and the anterior rectus sheath are divided along the line of incision.The rectus muscle is split longitudinally along the line of the incision and finally the posterior rectus sheath, transversalis fascia and peritoneum are divided in one layer.

The incision does not involve dissetion of the anterior rectus sheath from the rectus muscle, hence can be performed quicker. The theoretical disadvantage that the medial portion of the divided rectus becomes

denervated hence loses its strength is not very true in practice. It provides a strong scar in the long run.

Closure is similar to that of paramedian incision. Some surgeons prefer to apply a few interrupted stitches to bring together the two halves of the rectus muscle but that is not obligatory.

Oblique subcostal incision(Kocher's)-This incision provides good access to the upper abdominal organs such as gall bladder and bile duct on the right side and spleen on the left.This incision gives a wider access to obese patients with wider costal angles.

Incision starts in the midline just below the xiphoid process and runs downwards and laterally about 2cm below and parallel to the costal margin.The skin, subcutaneousn tissue and all the muscles including the rectus are divided along the line of incision. Obviously the peritoneum is also opened through the same line. The 8^{th},9^{th} and the 10^{th} intercostals nerves run the risk of being damaged, while running downwards and medially towards the midline between the internal oblique and transverses. Though some surgeons try to look for them and sacrifice one or only two nerves,yet many surgeons do not look for them and even use cutting diathermy for incising the muscles.

Though a few intercostals nerves are damaged in this incision,yet no weakness of the scar is found practically. So this incision is attaining popularity particularly for gall bladder operations.

Closure is carried out again in three layered fashion-of which the first layer comprises the peritoneum, the transversalis fascia and the posterior rectus sheath, the middle layer comprises the muscles and the final layer is the skin and subcutaneous tissue. In gall bladder operations, it is better to provide a drain to the hepato renal pouch of Morrison. But this drain should be inserted through a separate stab wound lateral and below the Kocher's incision.

Grid iron incision- This muscle splitting incision is commonly used for appendicectomy.The main advantage of this incision is that it does not damage any nerve and being muscle splitting it heals quickly. Inadvertently the subcostal nerve may be injured giving rise to inguinal hernia but this is very rare.

The incision is an oblique one and perpendicular to the right spinoumbilical line through the Mcburney's point of about 3-4inches in length,whose one third will be above the spinoumbilical line and two thirds will be below the same line. Though this is the classical position of Mcburney's Gridiron incision, yet the surgeon should try to feel the caecum first before planning the position of the incision as sometimes the caecum

with the appendix might lie higher up or even subhepatic. The skin, fascia of Camper and fascia of Scarpa are incised along the line of the incision. The fibres of the external oblique aponeurosis will be seen running along the line of the incision. They are simply split. If the incision is made higher up or a little laterally, one will be able to see the fleshy fibres of the muscle. The two margins of the divided aponeurosis are retracted. The muscle fibres of the internal oblique will be seen running perpendicular to the line of the incision . These fibres and the muscle fibres of the transverses abdominis are more or less running in the same direction and should be split by inserting the tip of artery forceps and then opening it by the handle of the scalpel. The fingers are then introduced and the muscle fibres are then retracted. The fingers are replaced by retractors to expose the fascia transversalis and the peritoneum. This is picked up by two artery forceps as one layer and incised to enter into the abdomen.

Sometimes it is very difficult to take the appendix out of the abdomen, either because it is stuck retroperitoneally by infection or peritoneal folds. In these case, the incision may require to be extended either upwards and laterally or downwards and medially. This is done by cutting the muscles in these directions.

Closure is done usually in four layers-first layer includes the peritoneum and fascia transversalis, second layer is the muscular layer

composed of split fibres of internal oblique and transversus, third layer is the aponeurotic layer of the external oblique, fourth layer is the skin and subcutaneous tissue.

Rutherford Morrison's muscle cutting incision-As the name suggests this is the muscle cutting incision. Otherwise it is similar to Mcburney's grid iron incision.Skin and superficial fascia are incised along the same line as described in Mcburney's incision. Muscles are cut along the line of the incision to get access to the peritoneum. This incision is mainly used for exposure of ureter and can be performed on both sides of the abdomen. This is also used for exposure of the external iliac vessels. Closure is carried out in the same way as described in Mcburney's incision.

Lanz's incision-This incision is the cosmetic counterpart of the Mcburney's incision. This is mainly employed in performing appendicectomy. Instead of making an oblique incision as the grid iron, a transverse incision is made of the interspinous crease. The deeper layers are incised and split in the same fashion as that of Mcburney's incision.

Battle's para rectal incision- This incision is made on the lower abdomen over the lateral part of the rectus muscle. The skin and subcutaneous tissue are incised along the line of the incision. The anterior rectus sheath is also divided in the same line. The rectus muscle is retracted medially to expose the posterior rectus sheath in the upper part of the

incision and fascia transversalis in the lower major part of the incision, where the posterior rectus sheath is absent below the arcuate line. The intercostal nerves should be retracted to get into the abdomen. But it may so happen that sacrifice of one or two nerves may be necessary. This will cause some weakness of that segment of the rectus muscle supplied by the nerve.

This incision was previously used for appendicectomy and for unilateral gynecological operations. But its popularity is on the wane as neither it gives proper access to the organ concerned nor it can be extended due to presence of intercostals nerves.

Closure is carried out in the same manner as that of paramedian incision.

Transverse incision- These incisions have got a reputation that they heal quickly. This is due to the fact that there will be less muscular tension on the suture lines during coughing and rise of intra abdominal pressure. Moreover these incisions lie on Langer's lines of the skin, so of greater cosmetic value .Lastly postoperative discomfort and chest complications are less with this incision.

These incisions can be made on the upper abdomen as well as on the lower abdomen.

In the upper abdomen , this incision is widely practiced in Ramstedt's operation, transverse colostomy etc. But some surgeons prefer to make this incision in many other abdominal operations due to its property of quick healing.

The skin and subcutaneous tissue are divided along the line of incision. Both the recti are divided transversely. This does not interfere with the nerve supply of the rectus muscle which is segmental. Moreover the rectus muscle does not retract as it is adherent at its tendinous intersections to the anterior rectus sheath. The peritoneum and fascia transversalis are incised in one layer and thus a wide access into abdomen is achieved.

Closure is brought about in three layers-the peritoneum, fascia transversalis and the posterior rectus sheath are closed in one layer, the anterior rectus sheath is closed as 2^{nd} layer and the skin and subcutaneous tissue are closed as the 3^{rd} layer. Transverse incisions, inspite of their advantages as has been mentioned earlier could not enjoy much popularity as they are time consuming and more hemorrhagic.

In the lower abdomen this incision is very widely practiced in the operations on the prostate. This is a transverse incision with slight curve downwards just above the pubis and below the hairline. The incision divides the skin, subcutaneous tissue and anterior rectus sheath. The two margins of the divided anterior rectus sheath are held with artery forceps and are

elevated from underlying recti both upwards and downwards by sharp dissection. The recti and the pyramidalis muscle are now widely separated by retractors.This will expose the transversalis fascia and the peritoneum. This is divided in case of operations within the peritoneal cavity. But this layer is swept upwards for extraperitoneal operations on the bladder and prostate.

SURGICAL SITE INFECTIONS

Despite improvements in operating room practices, instrument sterilization methods and better surgical technique, surgical site infections (SSIs) remain a major cause of postoperative morbidity and delay in discharge from the hospital.

SSI are the third most commonly reported nosocomial infections and accounts for 14-16 per cent of all nosocomial infections among hospital inpatients. The source of the pathogen are either exogenous which came from the instruments, gloves, operating room, even from any member of the surgical team or endogenous which came from the patients mucous membrane, skin or bowel.

At the end of surgery bacteria and other microorganisms contaminate all surgical wounds, but only a small number of patients actually develop a clinical infection. Whether an infection actually occurs depends on the number of bacteria entering the wound, type and virulence of the bacteria and the host defense mechanisms. In a study done to find the incidence of SSIs in clean and clean contaminated surgeries it was found that the risk also increases in cases where a drain was put as compared to cases without drainage tube.

Other factors affecting rates of SSIs include Obesity, malnutrition, associated comorbidities and immune compromised states.

A system of classification for operative wounds that is based on the degree of microbial contamination was developed by the US National Research Council group in 1964. Four wound classes with an increasing risk of SSIs were described: clean, clean-contaminated, contaminated and dirty. The simplicity of this system of classification has resulted in it being widely used to predict the rate of infection after surgery.

The surgical wound classification system can be divided into the following four categories:

Class I—clean

Class II—clean-contaminated

Class III—contaminated

Class IV—dirty or infected.

DEFINITION OF SSIs

Surgical site infections **-** are defined as infection occurring within 30 days after an operation or within 1 year if an implant is present, and at least one of the following:

- Purulent drainage, with or without laboratory confirmation, from the superficial incision.

- Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision.

- At least one of the following signs or symptoms of infection: pain or tenderness, localised swelling, redness, or heat and superficial incision is deliberately opened by surgeon, unless incision is culture-negative.

- Diagnosis of superficial incisional SSI by the surgeon or attending physician

Incisional SSIs are further divided into **superficial incisional** (that only involves skin and subcutaneous tissue) and **deep incisional** (those involving deeper soft tissue, including fascia and muscle layers).

Organ/ Space SSI are those infections occurs within 30 days after the operation if no implant is left in place or within one year if implant is in place and the infection appears to be related to the operation and infection involves any part of the anatomy (e.g. organs or spaces), other than the incision.

Reducing the Risk of Surgical Site Infections

Changes in definition of surgical site infection have focused attention on the factors associated with SSIs and are now being studied with a view to limiting the risk of infection. Host-related factors that lead to an increased risk of SSI include: -

- Extremes of age.

- Morbid obesity.

- Other co-morbid illness.

- Increased glucose levels (>200 mg/dL) in the immediate post-operative period (48- hours) were associated with increased SSI risk.

- Smoking delays primary wound healing and may increase the risk of SSI.

- Patients who are receiving steroids or other immuno-suppressive drugs pre-operatively may be predisposed to developing SSI.

- Malnutrition

- Prolonged pre-operative hospital stay.

- Perioperative transfusion.

Research has shown that surgical techniques, skin preparation and the timing and method of wound closure are significant factors that can influence the incidence of subsequent infection. Antibiotic prophylaxis has also had a positive impact after certain types of surgery. Many other factors have been identified as having an effect on the potential for infection and healthcare professionals should consider these before, during and after surgery. In 1999, CDC issued a number of guidelines for reducing the risk of SSIs. They can be grouped as follows

Operating Room Measures: Although all guidelines regarding Intraoperative Operating Room ventilation may not be financially possible they should be adhered to as much as possible.

a. Ventilation

1. Positive-pressure ventilation in the operating room with respect to the corridors and adjacent areas should be maintained.

2. A minimum of 15 air changes per hour, of which at least 3 should be fresh air should be ensured.

3. Air should be introduced at the ceiling, and exhaust near the floor.

4. Operating room doors should be kept closed except as needed for passage of equipment, personnel and the patient.

5. The number of personnel entering the operating room should be limited to necessary personnel.

b. Cleaning and disinfection of environmental surfaces

When visible soiling or contamination with blood or other body fluids of surfaces or equipment occurs during an operation, a disinfectant should be used to clean the affected areas before the next operation.

c. Sterilization of surgical instruments

1. All surgical instruments should be sterilized according to published guidelines.

2. Flash sterilization should be performed only for patient care items that will be used immediately (e.g., to reprocess an inadvertently dropped

instrument). It should not be used for reasons of convenience, as an alternative to purchasing additional instrument sets, or to save time.

Preoperative Measures

a. Method of hair removal- In a Cochrane review that included Eleven RCTs that compared hair removal (using either depilatory cream or razors) with no hair removal showed no statistically significant difference between the groups in terms of surgical site infections. It also showed that there were statistically significant more SSIs when people were shaved rather than clipped. There were also no difference in SSIs when patients are shaved or clipped one day before surgery or on the day of surgery. The recommendations therefore are: -

1. Hair should not be removed preoperatively unless the hair at or around the incision site interferes with the operation.

2. If hair is removed, it should be removed immediately before the operation, preferably with electric clippers.

3. Serum blood glucose levels should be adequately controlled in all diabetic patients

4. Stopping use of tobacco products should be encouraged preoperatively. Patients should be instructed to abstain from smoking for at least 30 days before elective operation.

5. The incision site should be thoroughly washed and cleaned to remove gross contamination before performing antiseptic skin preparation.

6. Whenever possible, all infections remote to the surgical site should be identified and treated before elective operation.

7. An appropriate antiseptic agent for skin preparation should be used (Table 1).

	Mechanism of Action	**Antimicrobial Coverage**	**Onset**	**Duration**	**Application**
Aqueous-iodophor	Free iodine – protein, DNA damage	Excellent for gram +ve bacteria, good for gram –ve, fungi, virus, mycobacteria	Intermediate	2 hours	2-step scrub and paint
Aq eo us-CHG	Disrupts membranes	Excellent for gram +ve, good for gram –	Intermediate	6 hours	2-step scrub and dry, repeat

		ve and virus, fair for fungus, poor for mycobacteria			
Alcohol-iodophor	Denatures protein, free iodine − protein, DNA damage	Improved gram –ve ,mycobacteria activity	Rapid	48 hours	1-step paint Dry time, minimum of 3 min on hairless surface
Alcohol-CHG	Denatures protein, disrupts membranes	Improved gram −ve, Mtb, fungal activity	Rapid	48 hours	Dry site: 30-sec Moist site: 2-min Dry time, minimum of 3 min on hairless surface

Visual Analogue Scale[9,15]

The Visual Analogue Scale (VAS) is a subjective measure of pain. It consists of a 10cm line that consists of two end-points representing ‘no pain’ and ‘worst pain imaginable’. Patients were asked to rate their pain by placing a mark on the line that correspond to their current level of pain. The distance along the line from the ‘no pain’ marker is then measured with a ruler giving a pain score out of 10.

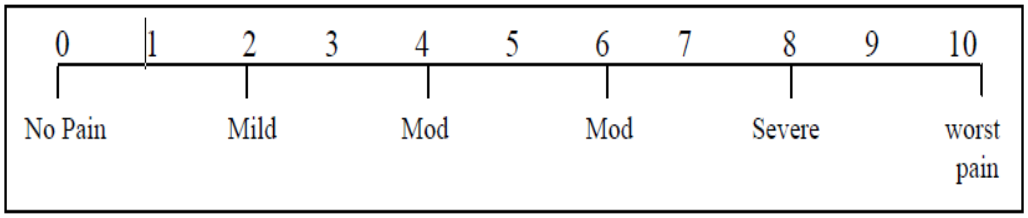
Interpretation of score :

The score can be used as a baseline assessment of pain with follow-up measures providing an indication of whether pain is reducing.The scores can also be used to evaluate treatment effectiveness.

I_____I

No pain **Worst pain**

Imaginable



MATERIALS AND METHODS

Patients whom underwent abdominal surgeries in both elective and emergency operation theatres in Tirunelveli Medical College hospital was included in this prospective study. Patients were randomly assigned to skin sutures/staplers for wound closure and 50 cases were studied in each group (total – 100 cases). Cases were studied from March 2012 – November 2013.

For all patients, subcutaneous sutures were put to relieve tension, dead space was closed and wound apposed. The wound was closed by skin staples or sutures. The wound was evaluated after 1 week, 1 month and 3 month interval for infection, swelling, discharge, overlapping of edges, separation of edges, wound dehiscence and scar. Photograph of the scar was taken for the evaluation of cosmetic appearance. A senior surgeon, who was unware of the method of closure, was consulted regarding the appearance of the scar.

Wound appearance was scored as follows :

1	-	overlapping borders	-	0 – yes, 1 - no
2	-	contour irregularities	-	0 – yes, 1 – no
3	-	wound dehiscence	-	0 – yes, 1 – no
4	-	good overall appearance	-	0 –poor, 1 - acceptable

Score of 4 – optimal cosmetic appearance

Visual Analogue Scale was used for examining post-operative pain.

Inclusion criteria:

Patients undergoing emergency and elective abdominal procedures will be included in this study.

Exclusion Criteria:

The following will be excluded from the study.

1. Traumatic wounds
2. Incisions which require to be closed under tension
3. Patients with diabetes mellitus
4. Patients with HIV
5. Age less than 12 years
6. Patients undergoing obstetrics and gynaecologic procedures

Skin closure

Suture

The skin was approximated usually with vertical mattress sutures using non-absorbable sutures at a distance of 1cm from each other.

Staple :

The edge of the wound was everted and lined up using toothed forceps. The stapler are then placed at a distance of 1cm from each other.

The time required for the closure of skin by either methods was recorded.

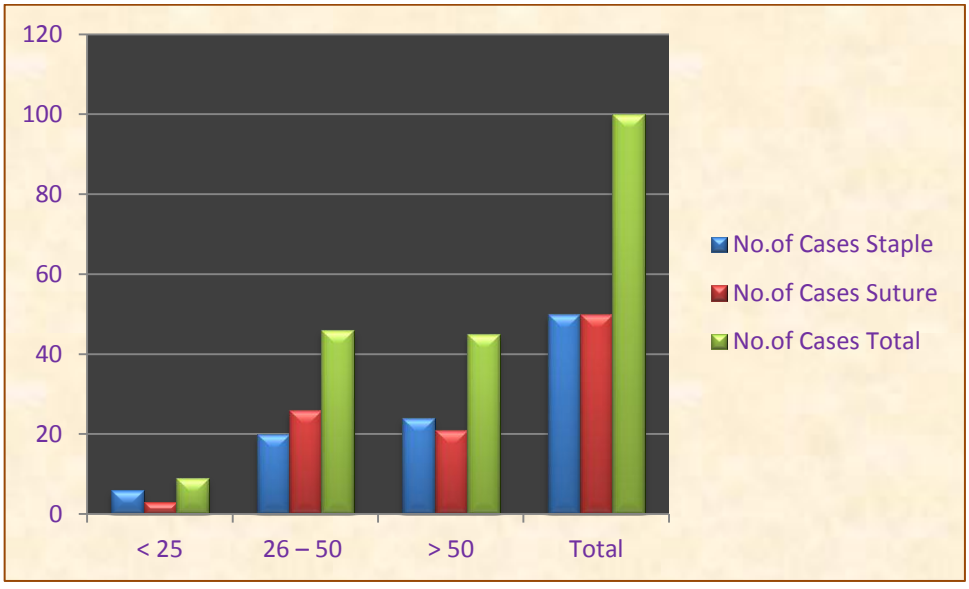
Ethical clearance was obtained from our institution for conducting the study.

Patients were looked up for complications – infection, discharge, gaping and wound dehiscence - during the post operative period. Patients were usually discharged after the removal of suture on 7^{th} - 8^{th} day. In case of wound infection/discharge in any group, the discharge was sent for culture and sensitivity. Patients were re-evaluated at 1^{st} month and 3^{rd} month.

OBSERVATION AND RESULTS

Table – 1.Age Distribution

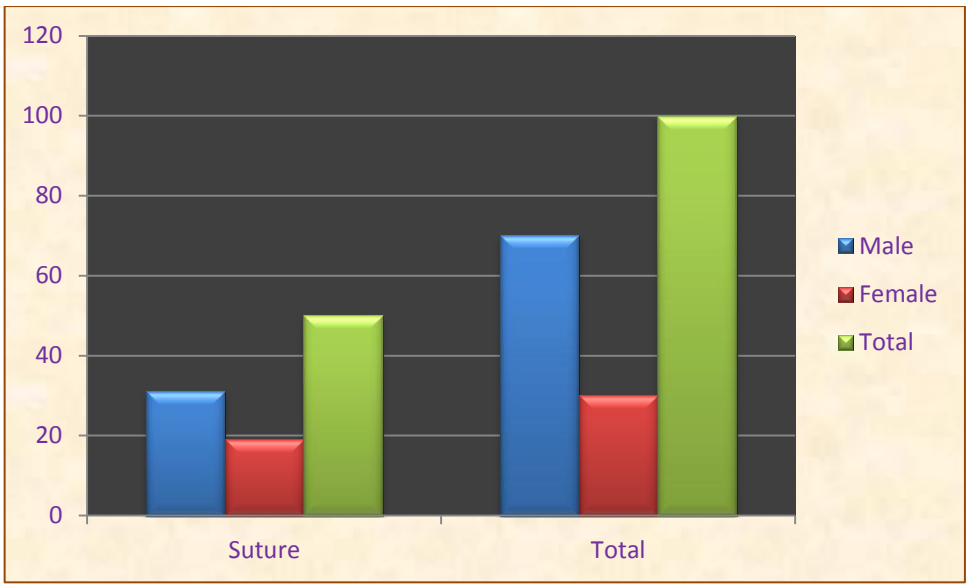
Age in years	No.of Cases		
	Staple	Suture	Total
< 25	6	3	9
26 – 50	20	26	46
> 50	24	21	45
Total	50	50	100



This table shows the age distribution of patients included in the study whom underwent closure of skin by either suture or staple.

Table -2.Sex distribution

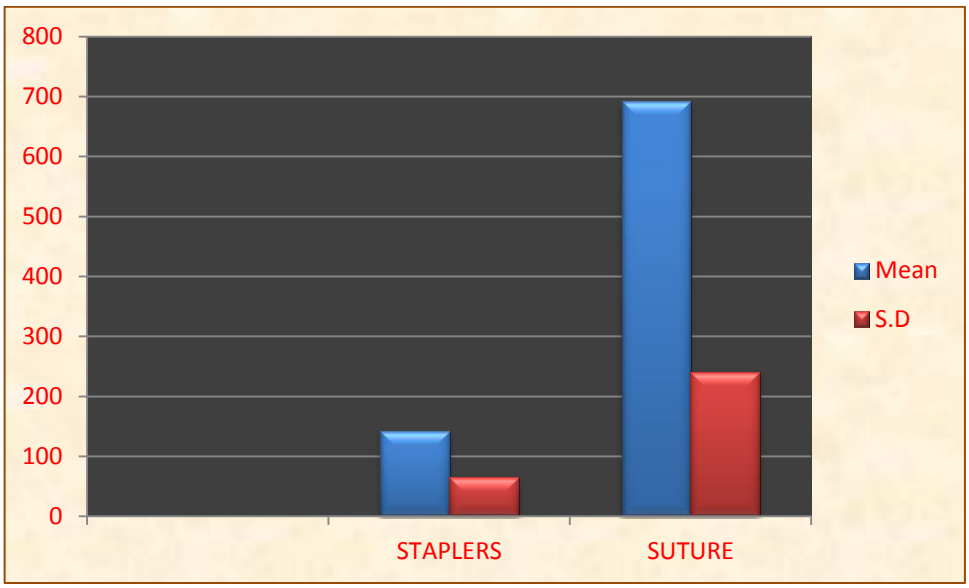
Suture/ Staple	Staple	Suture	Total
Male	39	31	70
Female	11	19	30
Total	50	50	100



This table shows the sex distribution of patients included in the study whom underwent closure of skin by either suture or staple.

Table – 3.Average Time for skin closure[in seconds]

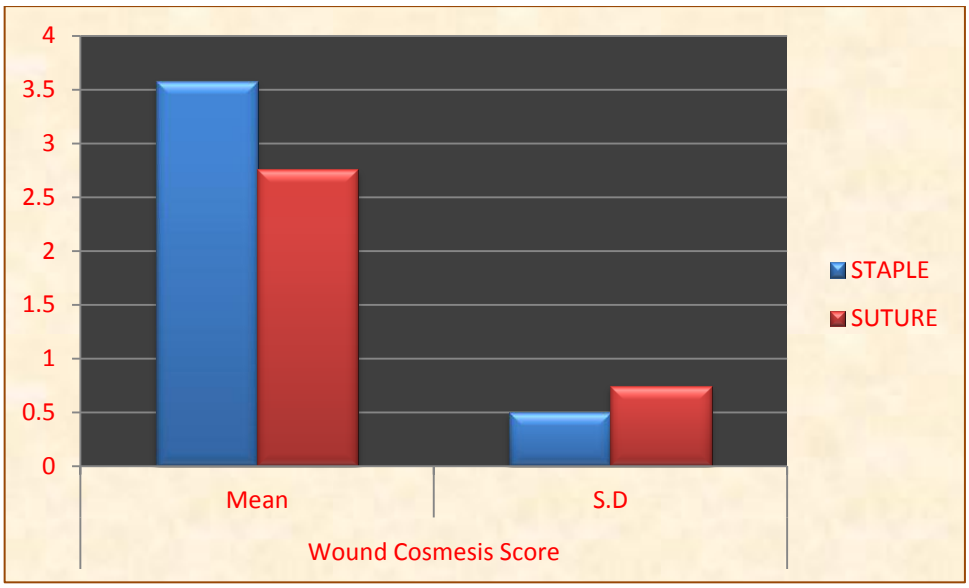
Suture/ Stapler	Mean [seconds]	S.D	P value
STAPLERS	141.800	64.695	
SUTURE	691.740	239.254	0.001



This table shows the average time taken for closure of skin by either suture or staplers. The average time for closure of skin by suture was 691.74 seconds and that of staplers was 141.8 seconds. The P value was found to be 0.001. Hence this was statistically significant.

Table – 4.Wound Cosmesis Score

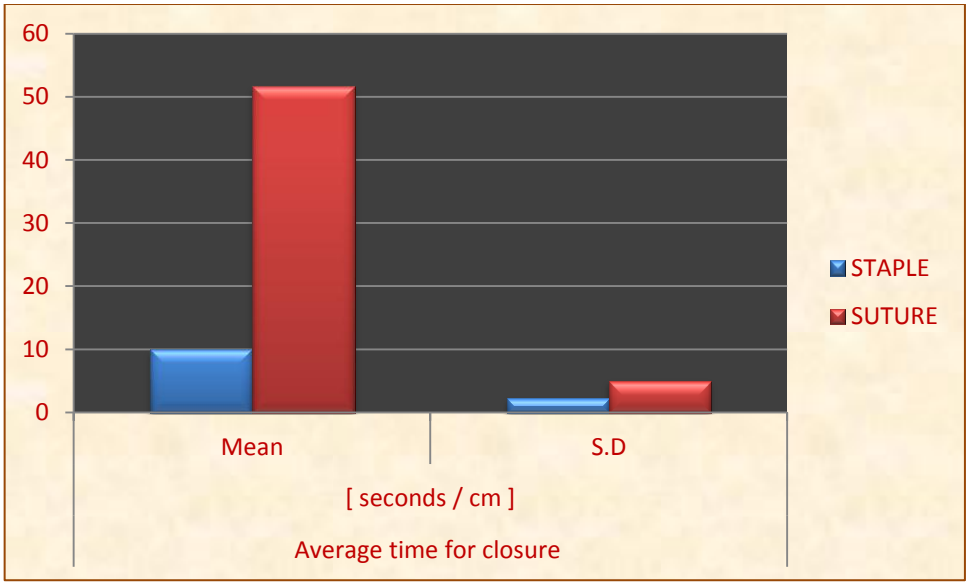
Suture/ Staple	Wound Cosmesis Score		
	Mean	S.D	P value
STAPLE	3.580	0.499	0.001
SUTURE	2.760	0.744	



This table shows the wound cosmesis score of patients whom underwent closure of skin by either suture or stapler. The P value was found to be 0.001. Hence this was statistically significant. The closure of skin by stapler was found to be cosmetically better.

Table -5.Average time for closure (Secs / cm)

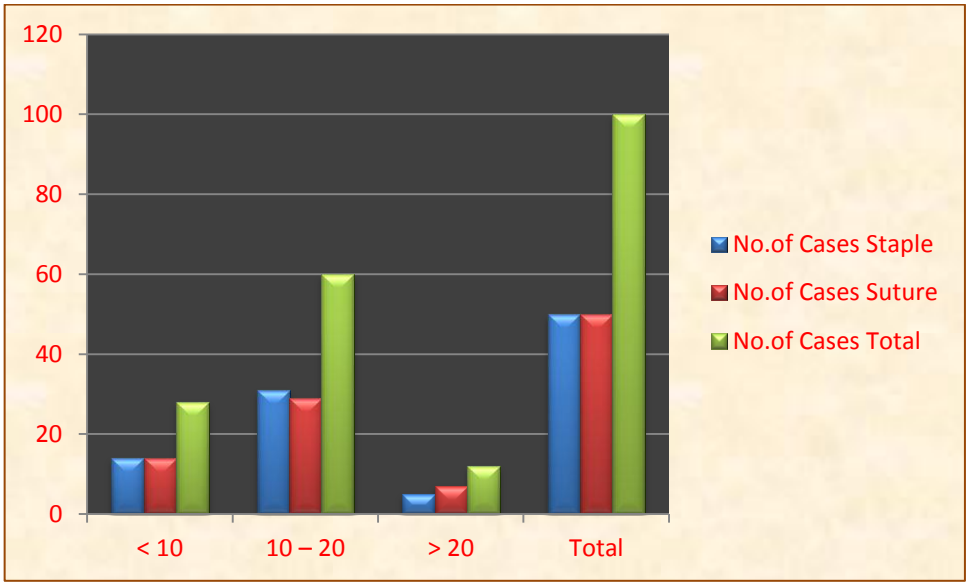
Suture/ Staple	Average time for closure [seconds / cm]		
	Mean	S.D	P value
STAPLE	9.969	2.257	< 0.001
SUTURE	51.66	4.962	



The average time for closure of skin by stapler was 9.96 sec/cm of the incision and that of suture was 51.66 sec/cm. The P value was found to be 0.001. Hence this was statistically significant.

Table – 6.Length of the incision

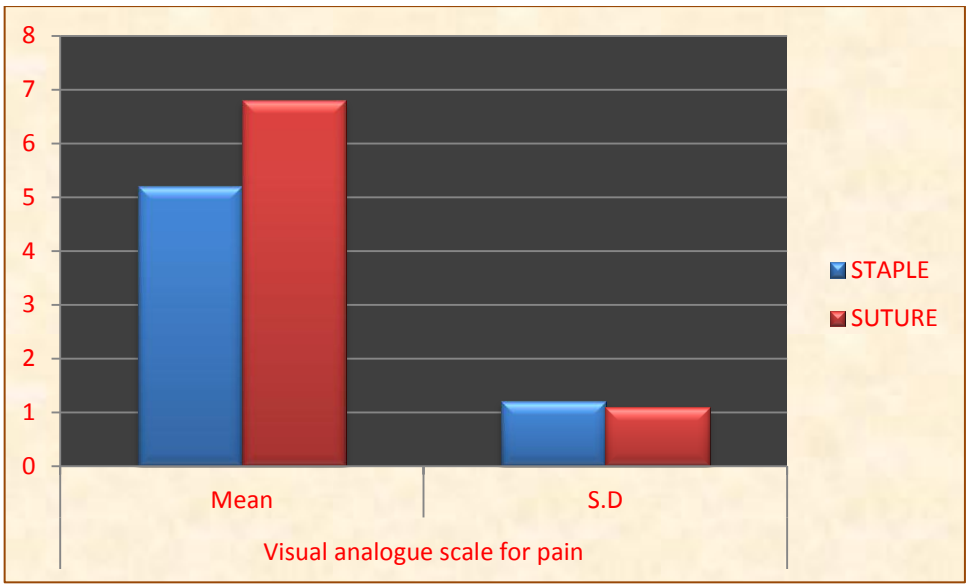
Length [cm]	No.of Cases		
	Stable	Suture	Total
< 10	14	14	28
10 – 20	31	29	60
> 20	5	7	12
Total	50	50	100



This table shows the distribution of cases according to the length of the incision.

Table -7.Visual Analogue Scale for Post operative Pain

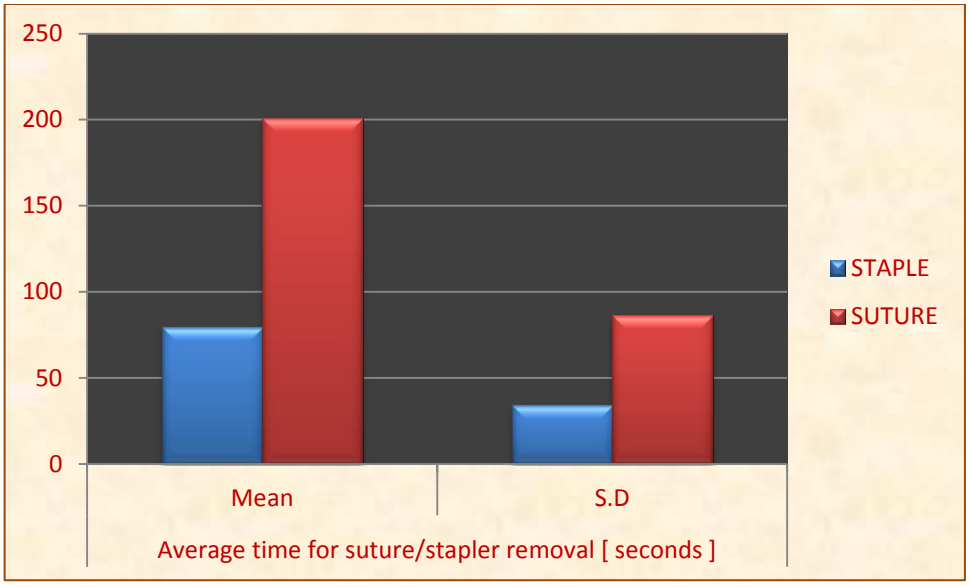
Suture/ Staple	Visual analogue scale for pain		
	Mean	S.D	P value
STAPLE	5.200	1.195	0.001
SUTURE	6.800	1.088	



This table shows the visual analogue scale tocompare post operative pain score for patients who underwent closure of skin by suture and staplers. The P value was found to be 0.001. Hence this was statistically significant. Thus the post operative pain was less in patients who underwent closure of skin by staplers.

Table – 8.Average Time for Suture/Stapler removal

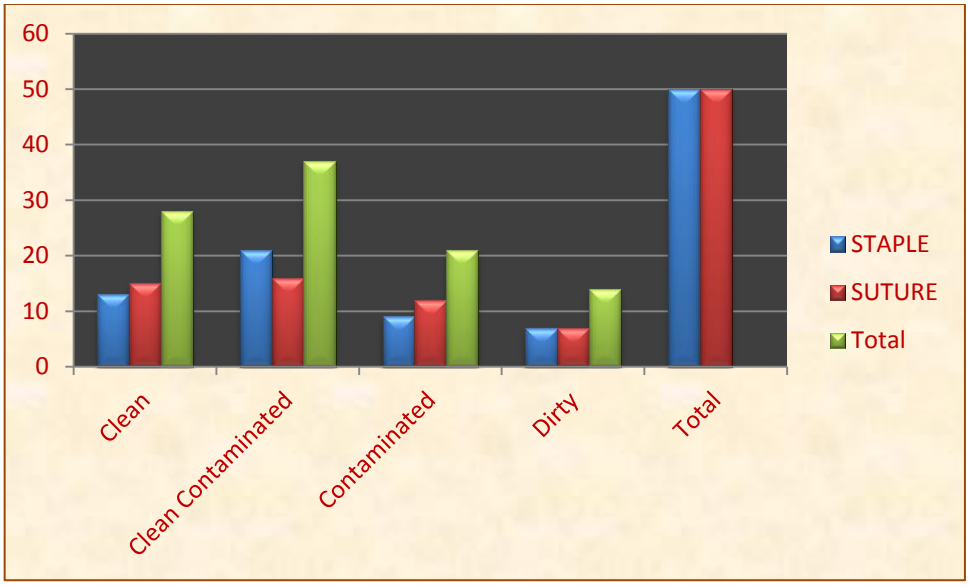
Suture/ Stapler	Average time for suture/stapler removal [seconds]		
	Mean	S.D	P value
STAPLE	79.680	34.273	0.001
SUTURE	200.700	86.250	



This table shows the average time taken to remove stapler and sutures. The P value was found to be 0.001. Hence this was statistically significant. The time taken to remove stapler was less when compared to sutures.

Table – 9.Character of Wound

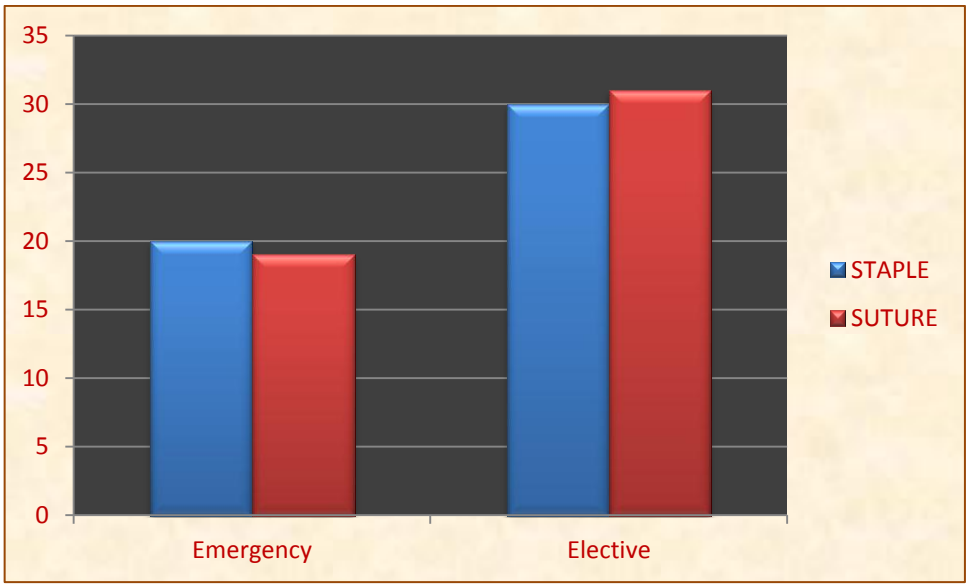
Suture/ Staple	Clean	Clean Contaminated	Contaminated	Dirty	Total
STAPLE	13	21	9	7	50
SUTURE	15	16	12	7	50
Total	28	37	21	14	



This table shows the distribution of type of wounds among the study group.

Table – 10.Emergency/Elective

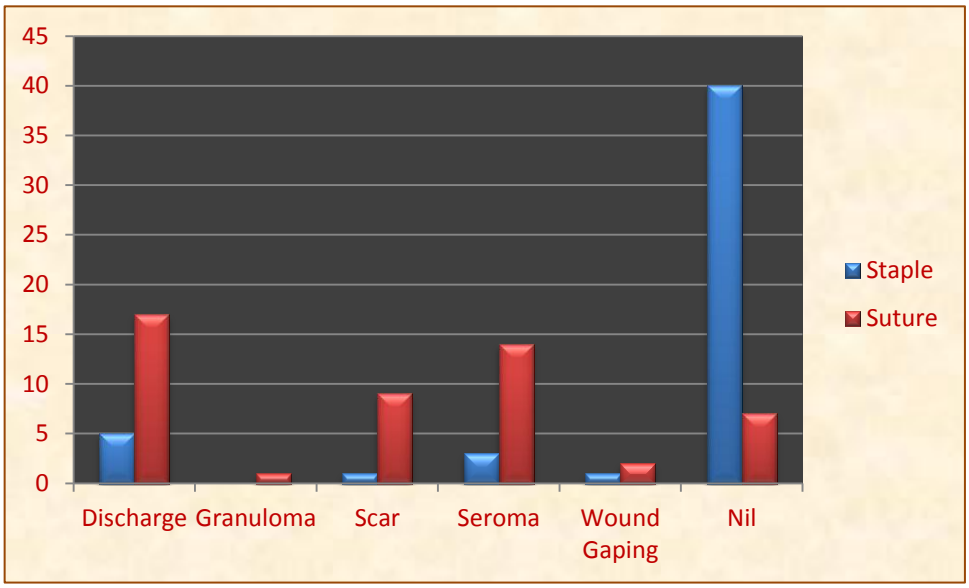
Suture/ Staple	Emergency	Elective
STAPLE	20	30
SUTURE	19	31



This table shows distribution of cases in the study group into emergency and elective theatres.

Table -11.Complication

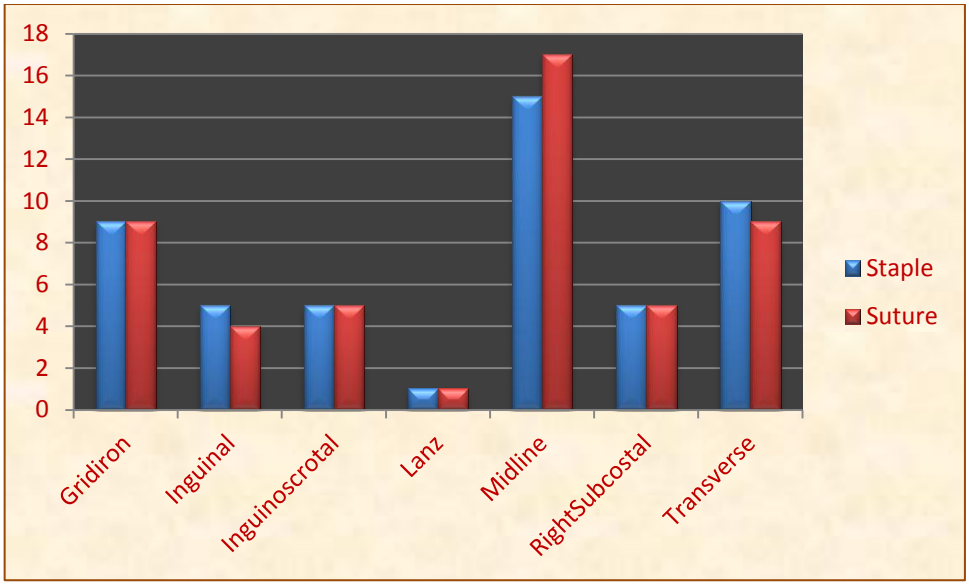
Complication	Staple	%	Suture	%	P value
Discharge	5	10	17	34	0.037
Granuloma	0	0	1	2	0.992
Scar	1	2	9	18	0.037
Seroma	3	6	14	28	0.027
Wound Gaping	1	2	2	4	0.986
Nil	40	80	7	14	-
Total	50	100	50	100	-



This table shows complications encountered in skin closure with sutures and staplers. About 20% of patients whom underwent skin closure by stapler had complications. Wound infection and discharge was the most common complication among this group. About 76% of patients whom underwent skin closure by sutures had complications. Wound infection and discharge was the most common complication among this group.

Table – 12.Incision

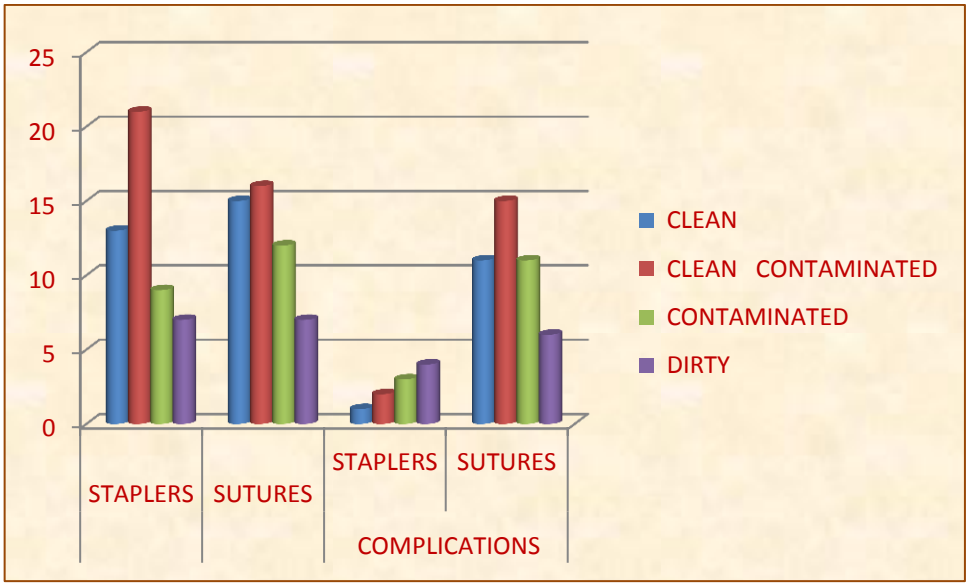
Incision	Stable	Suture
Gridiron	9	9
Inguinal	5	4
Inguinoscrotal	5	5
Lanz	1	1
Midline	15	17
RightSubcostal	5	5
Transverse	10	9



This table shows the distribution of various abdominal incisions closed with sutures and staplers.

Table - 13. Complications according to type of wound

	STAPLERS	***SUTURES***	***COMPLICATIONS***	
			STAPLERS	***SUTURES***
CLEAN	*13*	*15*	*1*	*11*
CLEAN CONTAMINATED	*21*	*16*	*2*	*15*
CONTAMINATED	*9*	*12*	*3*	*11*
DIRTY	*7*	*7*	*4*	*6*



This table shows the distribution of complication among patients who have undergone skin closure by either suture/stapler, based on the category of the wound.

1WEEK – STAPLER

1 WEEK - SUTURE

1 MONTH - STAPLER

1 MONTH – SUTURE

3 MONTH – STAPLER

3 MONTH – SUTURE

WOUND DEHISCENCE – SUTURES

DISCUSSION

Eventhough the sutures are inexpensive, they typically consume a longer duration and the risk of needle stick injury to the surgeon and the operating staff was high. The problems encountered while suturing the wound are

1. Needle stick injuries

2. Hematoma formation due to injury to the blood vessels in the skin

3. Onset of stitch abscess

In this prospective clinical study, 100 patients underwent surgeries in the abdomen [61 elective and 39emergency]. Out of this 100, 50 underwent skin closure with skin staplers while the remaining 50 had skin closure with non absorbable sutures. The comparison between these 2 groups was done by certain parameters like

1. Post -operative wound complications

2. Wound cosmesis

3. Post -operative pain

4. Time consumption

Wound complications:

This includes

1. Discharge/infection
2. Granuloma
3. Seroma
4. Wound gaping

In our study, 5 patients[10%] in the stapled group and 17 patients[34%] in the sutured group had wound infection/discharge. These wound discharge was sent to culture and sensitivity. The most common surgical site infection in both the groups was –

1. Staphylococcus
2. Klebsiella [Oxytoca and Pneumoniae]
3. Pseudomonas
4. Proteus
5. E.coli

This was statistically significant as the P value was 0.037[<0.05]. Hence wound infection and discharge was less with stapled group when compared to sutured group. Certain studies have shown that skin wounds

closed by staples exhibit a superior resistance to infection than skin wounds closed with sutures[10].

The sutures and staplers, after they were removed, was also sent for culture and sensitivity but there was no growth in both of these.

In our study, only 1 patient [2%] in suture group developed granuloma and no granuloma in stapled group. The P value was 0.992 and was not statistically significant.

In the present study, only 1 patient [2%] in stapled group had hypertrophic/ugly scar and 9 patients [18%] of sutured group had an ugly scar. The P value was 0.037[<0.05] and was statistically significant.

In this study, 3 patients[6%] in stapled group had seroma and 14 patients[28%] in sutured group had seroma. The P value was found to be 0.0027[<0.05] and was statistically significant.

In this comparative study, 1 patient[2%] in stapled group and 2 patient[4%] in sutured group had wound gaping. The P value was 0.986[>0.05] and hence not statistically significant.

In this study, 40 patients[80%] in stapled group and 7 patients[14%] in sutured group had no complications.

Wound cosmesis :

"By your scars you will be judged" - Fitz Gibbon in 1968.

All the patients included in the study were followed up at 1month and 3 month after discharge for evaluation of the scar. A senior surgeon was consulted, who was blinded to the method of closure, to evaluate the scar. Wound cosmesis score was calculated and compared. Mean of this score was 3.5 in stapled group and 2.7 in sutured group. The P value was 0.001 and was statistically significant.

Post operative pain :

Post operative pain for the patients in the study group was evaluated using visual analog scale. The average score was 5.2 in stapled group and 6.8 in the sutured group. The P value was 0.001 and was statistically significant.

Time consumption :

In this prospective study, the time taken for complete wound closure was significantly less with staplers when compared to that of sutures. The average time required to approximate 1cm of wound was 9.96 seconds with staplers whereas it was 51.66 seconds with sutures, about 5 times longer. The P value was 0.001 [<0.05] and was statistically significant.

Kanagaye also observed that staplers were about 6 times quicker than standard sutures[11].

Eldrup et al also concluded that mechanical sutures took one third the time taken by the conventional sutures[12].

Meiring et al have also concluded that there was 80% time saving and also Havery and Logan have concluded 66.6% time saving with staplers[13,14].

Cost :

The cost of stapler application for a patient cost about Rs. 450 and that of sutures vary between Rs.80 to Rs.200.

CONCLUSION

Cosmesis an important factor in todays modern era. A cosmetic scar gives patient satisfaction and a mental ease to the operating surgeon.

In our prospective comparative clinical study of skin staplers versus skin sutures in elective and emergency abdominal surgery, our inference was :

1. Wound infection / discharge was less with staplers.

2. Wound cosmesis was better with staplers.

3. Post operative pain was less with staplers.

4. Time consumed for skin closure with staplers was 5 times less than that of those closed with sutures.

5. Incidence of seroma was less with staplers.

Hence we conclude that skin staplers are superior to sutures for better wound cosmesis, in reducing the post operative pain, wound infection, seroma formation and very much significant in saving time for skin closure. Hence this study recommends the use of skin staplers.

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PROFORMA

Name :

I.P.no :

Age :

Address :

Unit :

Sex :

D.O.A :

D.O.S :

Phone :

D.O.D :

Diagnosis :

Surgery details

Incision :

Duration :

Length :

Procedure : Emergency / Elective

Theatre list :

Type of wound : CLEAN / CLEAN CONTAMINATED / CONTAMINATED / DIRTY

Type of skin closure : STAPLES / SUTURES

Average time consumed for closure :

Average time for suture/staple removal :

Complications during follow up

7days -

1 month -

3months -

Investigations :

Complete haemogram -

Random Blood Sugar -

Blood Urea -

Serum Creatinine -

Pus culture&sensitivity -

Local examination of the wound : swelling

Discharge

overlapping of edges

Separation of edges

wound dehiscence

scar

Visual analogue scale for pain :

Wound cosmesis score :

நோயாளிகளுக்கு அறிவிப்பு மற்றும் ஒப்புதல் படிவம்
மருத்துவ ஆய்வில் பங்கேற்பதற்கு

ஆய்வு செய்யப்படும் தலைப்பு :

பங்கு பெறுவரின் பெயர் :

பங்கு பெறுவரின் வயது :

		பங்கு பெறுவர் இதனை ✓ குறிக்கவும்
1	நான் மேலே குறிப்பிட்டுள்ள மருத்துவ ஆய்வின் விவரங்கள் நான் படித்து புரிந்து கொண்டேன். என்னுடைய சந்தேகங்களை கேட்கவும், அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்ப்பளிக்கப்பட்டுள்ளது என அறிந்து கொண்டேன்.	☐
2	நான் இவ்வாயில் தன்னிச்சையான தான் பங்கேற்கிறேன். எந்த காரணத்தினாலோ எந்த கட்டத்திலும், எந்த சட்ட சிக்கலுக்கும் உட்படாமல் நான் இவ்வாய்யில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்து கொண்டேன்.	☐
3	இந்த ஆய்வு சம்பந்தமாகவோ. இதை சார்ந்து மேலும் ஆய்வு மேற்கொள்ளும் போதும் இந்த ஆய்வில் பங்குபெறும் மருத்துவர் என்னுடைய மருத்துவ அறிக்கைகளை பார்ப்பதற்கு என் அனுமதி தேவையில்லை என அறிந்து அறிந்து கொள்கிறேன். நான் ஆய்வில் இருந்து விலகிக் கொண்டாலும் இது பொருந்தும் என அறிகிறேன்.	☐
4	இந்த ஆய்வில் மூலம் கிடைக்கும் தகவலையோ, முடிவையோ பயன்படுத்திக் கொள்ள மறுக்க மாட்டேன்.	☐
5	இந்த ஆய்வில் பங்கு கொள்ள ஒப்புக் கொள்கிறேன். எனக்கு கொடுக்கப்பட்ட அறிவுரைகளின் படி நடந்து கொள்வதுடன். ஆய்வை மேற்கொள்ளும் மருத்துவ அணிக்கு உண்மையுடன் இருப்பேன் என்று உறுதியளிக்கிறேன். என் உடல் நலம் பாதிக்கப்பட்டாலோ, அல்லது எதிர்பாராத, வழக்கத்திற்கு மாறான நோய்குறி தென்பட்டாலோ உடனே இதை மருத்துவ அணியிடம் தெரிவிப்பேன் என உறுதி அளிக்கிறேன்.	☐

பங்கேற்பவரின் கையொப்பம் / ..... இடம் ..... தேதி .....

கட்டைவிரல் ரேகை

பங்கேற்பவரின் பெயர் மற்றும் விலாசம் .....

ஆய்வாளரின் கையொப்பம் / ..... இடம் ..... தேதி .....

ஆய்வாளரின் பெயர் .....

மையம் .....

கல்வியறிவு இல்லாதவற்கு (கைரேகை வைத்தவர்களுக்கு) இது அவசியம் தேவை

சாட்சியின் கையொப்பம் / ..... இடம் ..... தேதி .....

பெயர் மற்றும் விலாசம் .....

S.NO	IP. NO	AGE(YRS	SEX	DIAGNOSIS	EMERGENCY / ELECTIVE	PROCEDURE	INCISION	LENGTH(CM)	CHARACTER OF THE WOUND	SUTURE / STAPLE	NO. OF SUTURES /STAPLES	AVERAGE TIME FOR SKIN CLOSURE(SEC)	WOUND COSMESIS SCORE	VISUAL ANALOGUE SCALE FOR PAIN	AVERAGE TIME FOR SUTURE/STAPLER REMOVAL(SEC)	COMPLICATIONS	THEATRE LIST
1	34993	37	F	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	6	CLEAN CONTAMINATED	STAPLE	6	61	3	2	28	NIL	1
2	134479	17	M	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	7	CLEAN CONTAMINATED	STAPLE	7	34	4	3	30	NIL	1
3	34916	22	M	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	5	CLEAN CONTAMINATED	STAPLE	5	27	4	5	22	NIL	1
4	9912	50	F	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	LANZ	5.5	CLEAN CONTAMINATED	STAPLE	5	29	3	4	24	NIL	2
5	51809	47	M	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	6	CLEAN CONTAMINATED	STAPLE	6	32	4	6	26	DISCHARGE	1
6	25011	35	M	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	5.5	CLEAN CONTAMINATED	SUTURE	5	355	4	7	47	SEROMA	2
7	22811	15	M	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	7	CLEAN CONTAMINATED	SUTURE	6	390	3	6	56	DISCHARGE	1
8	15311	42	M	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	6.5	CLEAN CONTAMINATED	SUTURE	6	375	2	5	55	NIL	2
9	58560	34	F	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	7.5	CLEAN CONTAMINATED	SUTURE	7	435	3	4	62	SEROMA	1
10	66132	42	M	SUB ACUTE APPENDICITIS	ELECTIVE	OPEN APPENDICECTOMY	GRID IRON	8	CLEAN CONTAMINATED	SUTURE	8	480	2	8	64	DISCHARGE	1
11	30593	49	M	ACUTE APPENDICITIS	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	6	CLEAN CONTAMINATED	STAPLE	6	60	4	5	28	NIL	1
12	25551	16	M	ACUTE APPENDICITIS	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	7	CLEAN CONTAMINATED	STAPLE	7	35	3	4	32	NIL	1
13	37823	44	M	ACUTE APPENDICITIS	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	8	CLEAN CONTAMINATED	STAPLE	8	45	4	3	35	NIL	1
14	40573	13	M	APPENDICULAR PERFORATION	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	5.5	CONTAMINATED	STAPLE	5	27	3	4	23	NIL	2
15	62330	44	F	ACUTE APPENDICITIS	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	6	CLEAN CONTAMINATED	STAPLE	6	30	4	6	29	NIL	1
16	29295	30	F	ACUTE APPENDICITIS	EMERGENCY	OPEN APPENDICECTOMY	LANZ	4	CLEAN CONTAMINATED	SUTURE	4	240	4	6	40	SEROMA	1
17	30387	22	M	ACUTE APPENDICITIS	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	7	CLEAN CONTAMINATED	SUTURE	6	370	3	5	57	DISCHARGE	1
18	30572	32	M	ACUTE APPENDICITIS	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	6	CLEAN CONTAMINATED	SUTURE	6	360	2	8	50	SCAR	2
19	37675	30	F	APPENDICULAR PERFORATION	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	8	CONTAMINATED	SUTURE	8	440	2	7	75	DISCHARGE	1
20	37712	18	M	APPENDICULAR PERFORATION	EMERGENCY	OPEN APPENDICECTOMY	GRID IRON	8	CONTAMINATED	SUTURE	7	430	3	7	76	SEROMA	1
21	28678	73	M	RIGHT STRANGULATED INGUINAL HERNIA	EMERGENCY	RESECTION AND ANASTOMOSIS	INGUINOSCROTAL	13	CONTAMINATED	STAPLE	13	150	3	5	90	SEROMA	1

22	9463	45	M	RIGHT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	12	CLEAN CONTAMINATED	STAPLE	12	130	4	4	75	NIL	1
23	29568	67	M	RIGHT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	11.5	CLEAN CONTAMINATED	STAPLE	11	120	4	6	70	NIL	1
24	28824	69	M	RIGHT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	12	CLEAN CONTAMINATED	STAPLE	12	130	3	5	70	NIL	1
25	29099	36	M	RIGHT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	12.5	CLEAN CONTAMINATED	STAPLE	12	140	4	7	80	NIL	1
26	34645	70	M	RIGHT STRANGULATED INGUINAL HERNIA	EMERGENCY	RESECTION AND ANASTOMOSIS	INGUINOSCROTAL	15	CONTAMINATED	SUTURE	15	790	3	7	225	DISCHARGE	3
27	62796	73	M	RIGHT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	12.5	CLEAN CONTAMINATED	SUTURE	12	615	2	8	180	SEROMA	2
28	31651	41	M	LEFT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	13	CLEAN CONTAMINATED	SUTURE	13	660	2	8	195	DISCHARGE	3
29	65048	32	M	RIGHT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	12	CLEAN CONTAMINATED	SUTURE	12	610	3	7	190	SEROMA	1
30	27100	37	M	LEFT OBSTRUCTED INGUINAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	INGUINOSCROTAL	14	CLEAN CONTAMINATED	SUTURE	13	700	2	6	210	SCAR	1
31	25552	65	M	RIGHT COMPLETE INGUINAL HERNIA	ELECTIVE	RIGHT HERNIOPLASTY	INGUINAL	14	CLEAN CONTAMINATED	STAPLE	14	180	3	5	95	NIL	1
32	35471	61	M	BILATERAL INGUINAL HERNIA	ELECTIVE	BILATERAL HERNIOPLASTY	INGUINAL	9 & 8	CLEAN	STAPLE	9 & 8	110 & 105	4	6	60 & 60	DISCHARGE	1
33	30942	58	M	RIGHT INGUINAL HERNIA	ELECTIVE	RIGHT HERNIOPLASTY	INGUINAL	8	CLEAN	STAPLE	8	75	3	4	60	NIL	1
34	31050	42	M	LEFT INGUINAL HERNIA	ELECTIVE	LEFT HERNIOPLASTY	INGUINAL	7.5	CLEAN	STAPLE	7	70	4	5	55	NIL	1
35	39061	65	M	RIGHT INGUINAL HERNIA	ELECTIVE	RIGHT HERNIOPLASTY	INGUINAL	8	CLEAN	STAPLE	8	80	4	6	55	NIL	2
36	45697	72	M	LEFT INGUINAL HERNIA	ELECTIVE	LEFTHERNIOPLASTY	INGUINAL	8	CLEAN	SUTURE	8	490	3	6	180	DISCHARGE	1
37	86765	55	M	BILATERAL INGUINAL HERNIA	ELECTIVE	BILATERAL HERNIOPLASTY	INGUINAL	8 & 8	CLEAN	SUTURE	7	405	4	7	120	NIL	1
38	49621	58	M	BILATERAL INGUINAL HERNIA	ELECTIVE	OPEN POSTERIOR HERNIOPLASTY	MIDLINE	10	CLEAN	SUTURE	9	600	4	7	180	DISCHARGE	2
39	59671	61	M	RIGHT INGUINAL HERNIA	ELECTIVE	RIGHT HERNIOPLASTY	INGUINAL	9	CLEAN	SUTURE	9	495	3	8	220	SEROMA	1
40	68764	34	M	RIGHT INGUINAL HERNIA	ELECTIVE	RIGHT HERNIOPLASTY	INGUINAL	8	CLEAN	SUTURE	7	450	4	7	180	NIL	1
41	44817	56	F	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	13	CLEAN	SUTURE	13	650	2	6	210	SEROMA	2
42	32496	65	M	EPIGASTRIC HERNIA	ELECTIVE	MESH REPAIR	MIDLINE	14	CLEAN	SUTURE	14	716	3	6	220	DISCHARGE	1
43	55652	70	F	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	12	CLEAN	SUTURE	12	465	2	5	165	SCAR	1
44	13658	50	M	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14	CLEAN	SUTURE	14	660	4	7	230	SEROMA	2
45	69204	51	M	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	13	CLEAN	SUTURE	13	585	4	5	220	DISCHARGE	1
46	29498	53	M	UMBILICAL HERNIA	EMERGENCY	RELEASE MESH REPAIR	TRANSVERSE	15	CLEAN CONTAMINATED	STAPLE	15	177	4	5	95	NIL	2

47	7958	68	M	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14	CLEAN	STAPLE	14	165	4	6	75	NIL	1
48	40540	65	M	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14.5	CLEAN	STAPLE	14	175	3	6	85	NIL	1
49	30916	56	F	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	13.5	CLEAN	STAPLE	13	170	4	7	60	NIL	1
50	53078	36	M	UMBILICAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	13	CLEAN	STAPLE	13	165	3	5	70	NIL	2
51	49245	55	F	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14	CLEAN	STAPLE	14	159	3	6	88	NIL	1
52	40618	52	M	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	13	CLEAN	STAPLE	13	150	4	4	80	NIL	1
53	37758	60	M	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14	CLEAN	STAPLE	14	158	4	4	90	NIL	1
54	46192	30	F	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	15	CLEAN	STAPLE	15	180	3	7	105	NIL	1
55	33310	41	M	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14	CLEAN	STAPLE	14	160	4	6	90	NIL	3
56	29405	34	F	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	12	CLEAN	SUTURE	12	640	2	5	190	NIL	1
57	45746	46	F	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	12	CLEAN	SUTURE	12	690	3	6	195	SEROMA	2
58	33265	60	F	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14.5	CLEAN	SUTURE	14	730	4	7	240	NIL	1
59	37728	45	F	INCISIONAL HERNIA	ELECTIVE	MESH REPAIR	TRANSVERSE	14	CLEAN	SUTURE	14	715	2	8	240	DISCHARGE	1
60	23295	42	M	INCISIONAL HERNIA	EMERGENCY	RELEASE AND MESH REPAIR	TRANSVERSE	15	CLEAN CONTAMINATED	SUTURE	15	765	3	6	250	GRANULOMA	1
61	37704	60	F	GIST	ELECTIVE	LAPAROTOMY - BIOPSY	MIDLINE	15.5	CLEAN CONTAMINATED	STAPLE	15	160	4	4	79	NIL	1
62	33503	75	M	INTESTINAL OBSTRUCTION	ELECTIVE	LAPAROTOMY - RESECTION AND ANASTOMOSIS	MIDLINE	21	CONTAMINATED	STAPLE	21	220	3	4	120	DISCHARGE	1
63	20773	60	F	CA STOMACH	ELECTIVE	LAPAROTOMY - DISTAL GASTRECTOMY WITH PGJ	MIDLINE	20	CONTAMINATED	STAPLE	20	218	4	6	120	NIL	1
64	28256	65	M	CA STOMACH	ELECTIVE	LAPAROTOMY - AGJ WITH JJ	MIDLINE	19	CONTAMINATED	STAPLE	19	196	4	8	110	NIL	1
65	15443	26	M	GASTRIC OUTLET OBSTRUCTION	ELECTIVE	TVGJ	MIDLINE	16.5	CONTAMINATED	STAPLE	16	180	3	5	91	NIL	1
66	50688	70	M	CA STOMACH	ELECTIVE	SUBTOTAL GASTRECTOMY AND PGJ	MIDLINE	24	CONTAMINATED	STAPLE	23	255	3	5	150	NIL	1
67	25434	16	M	PERFORATIVE PERITONITIS	EMERGENCY	ILEAL PERFORATION CLOSURE	MIDLINE	20	DIRTY	STAPLE	20	220	4	7	130	SEROMA	1
68	25232	24	M	PERFORATIVE PERITONITIS	EMERGENCY	GASTRIC PERFORATION CLOSURE - OMENTAL PATCH	MIDLINE	17	DIRTY	STAPLE	17	180	3	6	90	NIL	1
69	28205	30	M	PERFORATIVE PERITONITIS	EMERGENCY	RESECTION AND ANASTOMOSIS	MIDLINE	21	DIRTY	STAPLE	21	222	4	4	130	WOUND GAPING	2
70	28267	60	M	PERFORATIVE PERITONITIS	EMERGENCY	PALLIATIVE AGJ	MIDLINE	23.5	DIRTY	STAPLE	23	240	3	5	150	DISCHARGE	3
71	34046	50	M	PERFORATIVE PERITONITIS	EMERGENCY	GASTRIC PERFORATION CLOSURE - OMENTAL PATCH	MIDLINE	16.5	DIRTY	STAPLE	16	170	4	6	95	NIL	3

72	31335	42	M	PERFORATIVE PERITONITIS	EMERGENCY	DUODENAL PERFORATION CLOSURE - OMENTAL PATCH	MIDLINE	18.5	DIRTY	STAPLE	18	198	3	5	120	SCAR	1
73	31622	73	M	BLUNT INJURY ABDOMEN	EMERGENCY	EXPLORATORY LAPAROTOMY - LIVER LACERATION	MIDLINE	22.5	CLEAN CONTAMINATED	STAPLE	22	230	4	7	130	NIL	1
74	34994	58	M	UMBILICAL FISTULA	EMERGENCY	UMBILICECTOMY AND EXCISION OF TRACT	MIDLINE	20	CONTAMINATED	STAPLE	20	215	3	6	120	NIL	2
75	63209	48	M	PERFORATIVE PERITONITIS	EMERGENCY	DUODENAL PERFORATION CLOSURE - OMENTAL PATCH	MIDLINE	16.5	DIRTY	STAPLE	16	160	4	6	95	NIL	1
76	37466	53	M	OBSTRUCTIVE JAUNDICE	ELECTIVE	TRIPLE BYEPASS	MIDLINE	23.5	CONTAMINATED	SUTURE	23	1140	2	9	370	DISCHARGE	1
77	4967	50	M	GASTRIC OUTLET OBSTRUCTION	ELECTIVE	TVGJ	MIDLINE	18	CONTAMINATED	SUTURE	18	840	3	8	300	SEROMA	1
78	34907	65	M	CA STOMACH	ELECTIVE	AGJ WITH JJ	MIDLINE	20	CONTAMINATED	SUTURE	20	965	2	7	310	DISCHARGE	1
79	59625	49	M	TAO	ELECTIVE	LUMBAR SYMPATHECTOMY	MIDLINE	16	CLEAN	SUTURE	16	752	3	6	240	DISCHARGE	2
80	58433	65	M	CA STOMACH	ELECTIVE	PALLIATIVE AGJ	MIDLINE	17.5	CONTAMINATED	SUTURE	17	900	2	8	240	SEROMA	1
81	23077	58	F	HYDATID CYST OF LIVER	ELECTIVE	DRAINAGE AND EXCISION	MIDLINE	23	DIRTY	SUTURE	23	1110	2	8	300	DISCHARGE	1
82	33412	60	F	PERFORATIVE PERITONITIS	EMERGENCY	GASTRIC PERFORATION CLOSURE - OMENTAL PATCH	MIDLINE	16	DIRTY	SUTURE	16	790	3	6	250	SCAR	2
83	29719	32	M	PERFORATIVE PERITONITIS	EMERGENCY	DUODENAL PERFORATION CLOSURE - OMENTAL PATCH	MIDLINE	15	DIRTY	SUTURE	15	730	2	7	240	SEROMA	2
84	61196	43	M	INTESTINAL OBSTRUCTION	EMERGENCY	ADHESION RELEASE	MIDLINE	22.5	CLEAN CONTAMINATED	SUTURE	22	992	2	8	330	SCAR	2
85	60347	72	M	PERFORATIVE PERITONITIS	EMERGENCY	GASTRIC PERFORATION CLOSURE - OMENTAL PATCH	MIDLINE	15	DIRTY	SUTURE	15	733	2	6	240	WOUND GAPING	1
86	58309	42	M	SMALL BOWEL GANGRENE	EMERGENCY	RESECTION AND ANASTOMOSIS	MIDLINE	23	DIRTY	SUTURE	22	1200	3	8	273	DISCHARGE	1
87	61121	60	M	PENETRATING INJURY ABDOMEN	EMERGENCY	EXPLORATORY LAPAROTOMY	MIDLINE	21	DIRTY	SUTURE	20	1035	2	7	300	DISCHARGE	1
88	58250	44	F	CA STOMACH	ELECTIVE	AGJ AND JJ	MIDLINE	20	CONTAMINATED	SUTURE	20	994	3	6	300	NIL	1
89	58380	65	F	SIGMOID VOLVULUS	EMERGENCY	RESECTION AND ANASTOMOSIS WITH LOOP COLOSTOMY	MIDLINE	23	DIRTY	SUTURE	23	1140	3	8	310	NIL	1
90	30567	40	F	SUB ACUTE INTESTINAL OBSTRUCTION	EMERGENCY	ADHESION RELEASE	MIDLINE	22	CLEAN CONTAMINATED	SUTURE	22	1095	2	7	290	SCAR	3
91	18586	74	M	OBSTRUCTIVE JAUNDICE	ELECTIVE	CHOLECYSTECTOMY WITH CBD EXPLORATION	RIGHT SUBCOSTAL	16	CONTAMINATED	STAPLE	16	170	3	5	95	DISCHARGE	1
92	10795	40	F	CHOLEDOCHOLITHIASIS	ELECTIVE	CHOLECYSTECTOMY WITH CBD EXPLORATION	RIGHT SUBCOSTAL	18	CONTAMINATED	SUTURE	18	840	4	7	285	WOUND GAPING	1
93	58101	75	F	CHOLEDOCHOLITHIASIS WITH CHOLELITHIASIS	ELECTIVE	CHOLECYSTECTOMY WITH CBD EXPLORATION	RIGHT SUBCOSTAL	18	CONTAMINATED	SUTURE	18	855	3	6	260	SCAR	1
94	69363	35	F	CALCULOUS CHOLECYSTITIS	ELECTIVE	CHOLECYSTECTOMY WITH CBD EXPLORATION	RIGHT SUBCOSTAL	14	CONTAMINATED	SUTURE	14	690	2	8	180	SEROMA	1
95	69369	55	F	CHOLEDOCHOLITHIASIS	ELECTIVE	CHOLECYSTECTOMY WITH CBD EXPLORATION	RIGHT SUBCOSTAL	14.5	CONTAMINATED	SUTURE	14	690	3	7	180	SCAR	1
96	28688	38	F	CHOLELITHIASIS	ELECTIVE	CHOLECYSTECTOMY	RIGHT SUBCOSTAL	15.5	CLEAN CONTAMINATED	SUTURE	15	790	3	8	215	SCAR	1

97	30310	30	F	CHOLELITHIASIS	ELECTIVE	CHOLECYSTECTOMY	RIGHT SUBCOSTAL	15	CLEAN CONTAMINATED	STAPLE	15	160	3	5	90	SEROMA	1
98	2910	50	F	CHOLELITHIASIS	ELECTIVE	CHOLECYSTECTOMY	RIGHT SUBCOSTAL	16	CLEAN CONTAMINATED	STAPLE	15	160	4	4	86	NIL	2
99	47969	71	M	CHOLELITHIASIS	ELECTIVE	CHOLECYSTECTOMY	RIGHT SUBCOSTAL	16	CLEAN CONTAMINATED	STAPLE	15	162	4	6	88	NIL	2
100	27146	38	F	CHOLELITHIASIS	ELECTIVE	CHOLECYSTECTOMY	RIGHT SUBCOSTAL	14	CLEAN CONTAMINATED	STAPLE	14	150	4	5	70	NIL	1

ABBREVIATIONS USED :

GIST	-	GASTRO INTESTINAL STROMAL TUMOUR
CA	-	CARCINOMA
PGJ	-	POSTERIOR GASTROJEJUNOSTOMY
AGJ	-	ANTERIOR GASTROJEJUNOSTOMY
JJ	-	JEJUNOJEJUNOSTOMY
TVGJ	-	TRUNCAL VAGOTOMY AND GASTROJEJUNOSTOMY
TAO	-	THROMBO ANGITIS OBLITERANS